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A Monograph of the Lichen Genus *Parmelina* Hale (Parmeliaceae)

MASON E. HALE, JR.

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A Monograph of the Lichen Genus *Parmelina* Hale (Parmeliaceae)

Mason E. Hale, Jr.

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ABSTRACT

Hale, Mason E., Jr. A Monograph of the Lichen Genus *Parmelina* Hale (Parmeliaceae). *Smithsonian Contributions to Botany,* number 33, 60 pages, 21 figures, 1976.—The 47 species of *Parmelina* are revised on the world level. Two sections are recognized: section *Parmelina* with 30 species widely distributed in temperate to tropical montane regions and section *Myelochroa* with 17 terpene-containing species concentrated in eastern and southern Asia. The genus is most closely related to *Parmotrema* Massalongo. Five new species, *P. crassata* Hale, *P. degelii* Hale *P. indica* Hale, *P. rhytidodes* Hale, and *P. schindleri* Hale, are described, and six new combinations proposed, *P. amagiensis* (Asahina) Hale, *P. damaziana* (Zahlbruckner) Hale, *P. endoleuca* (Taylor) Hale, *P. irrugans* (Nylander) Hale, *P. jamesii* (Hale) Hale, and *P. pastillifera* (Harmand) Hale. New combinations are also made for *Hypotrachyna baguioensis* (Hale) Hale and *Parmotrema nylanderi* (Lynge) Hale.

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A Monograph of the Lichen Genus *Parmelina* Hale (Parmeliaceae)

Mason E. Hale, Jr.

Introduction

The genus *Parmelina* Hale is a segregate of *Parmelia* Acharius comprising 47 species widely distributed in temperate and tropical regions. It is recognized by the narrow, adnate lobes, marginal cilia, and absence of usnic acid in the cortex (Hale, 1974:438). Some of the species included here were formerly classified in the ill-defined (and invalid) genus *Imbricaria* (Schreber) Michaux (Hale and Kurokawa, 1964:130). This world level monograph is based on the study of all available type specimens, collections preserved in the major herbaria, and personal field work. The format follows my earlier treatments of *Bulbothrix* (Hale, 1976b), *Hypotrachyna* (Hale, 1975a), *Pseudoparmelia* (Hale, 1976a), and *Relicina* (Hale, 1975b).

I wish to thank curators of the following institutions who sent specimens on loan so promptly and often allowed extensions of loan periods: BM, BO, BP, COLO, DUKE, F, FH, FI, G, GLAM, H, KAN, KR, L, LD, M, MICH, MSC, MVM, NSW, NY, PC, PH, REN, S, SI, TNS, TRH, TUR, UC, UPS, W, WIS, WU, and ZT. Specimens in TNS were annotated during 1964–65 while I studied in Tokyo. The private herbaria of Dr. D. D. Awasthi, Dr. Gunnar Degelius, Dr. S. Nakanishi, Dr. Clyde Reed, and Dr. R. Santesson were also generously placed at my disposal. The material in these various herbaria was chemically tested and annotated between 1958 and 1975, but not all of it has been reexamined for possible name changes in the light of new synonymies, species concepts, or improved chemical techniques.

Any monograph is bound to be more complete if the author has had an opportunity to observe and collect specimens in the field. I am especially grateful to the following colleagues for assistance in arranging excursions: Mr. J. Anderson (Sarawak), Mrs. Sheila Collenette (Sabah), Dr. S. Kurokawa (Japan), Dr. M. López-Figueiras (Venezuela), Dr. W. Meijer (Sabah), Dr. M. Nakanishi and Dr. S. Nakanishi (Japan), Dr. P. G. Patwardhan (India), Dr. Stella Thrower (Hong Kong), and Dr. Flora Uyenco (Philippines). I have also conducted field studies in Mexico and Central America, the Lesser Antilles, and Malaya.

The scanning-electron photographs were prepared by the Smithsonian Scanning-Electron Microscope Laboratory. Photographs of the specimens were taken by the Smithsonian Photographic Services.

Grants in support of this research have been received from the National Science Foundation (Systematic Biology and the U. S.–Japan Cooperative Science Program), Morden-Smithsonian Expedition to Dominica, National Geographic Society, and the Smithsonian Research Foundation.

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Morphology

Thallus Structure.—*Parmelina* basically has a closely appressed to adnate foliose thallus with narrow lobes (1–4 mm wide). Most species have more or less subirregular lobation and apically rotund lobes (Figures 16*e*, 18*b*), although narrow lobed species are sublinear (Figures 12*d*, 16*c*,). There is, however, a wide range of variation in lobe configuration and width, much more than exists, for example, in *Hypotrachyna* (Hale, 1975a).

The internal anatomy is similar to that of other epicorticate genera (Hale, 1973a). A thin, generally palisade plectenchymatous cortex is overlain by a pored epicortex (Figures 1 and 2). The medulla consists of loosely packed hyphae, often encrusted with lichen substances (Figure 2*f*). The lower cortex is paraplectenchymatous (Figure 2*a–d*).

The upper surface is strongly white maculate in *Parmelina consors* (Figure 3*a*), *P. muelleri*, and *P. pilosa*, less conspicuously so in *P. melanochaeta*, *P. pastillifera*, *P. quercina*, and *P. tiliacea*, and faintly or not at all in the remaining species.

The lower surface is black with only three exceptions. *Parmelina enormis* has a uniformly pale brown lower surface, and *P. expallida* and *P. versiformis* are darker brown tending toward black at the center.

Cilia.—The marginal cilia which characterize *Parmelina* are usually distinct but may be variably dispersed around the lobe margins. In many species they occur more or less regularly both on lobe tips and in the axils (Figures 3*a*, 17*a*, 18*b*). In others cilia may be lacking at the lobe tips and confined to the axils (Figure 3*b*) or may be so sparse and inconspicuous in a few species, such as *P. simplicior*, that they are overlooked. In these cases one might tend to classify them in the genus *Pseudoparmelia* (Hale, 1976a), which is differentiated from *Parmelina*, among other ways, by the total absence of marginal cilia. Great care must be taken to establish the presence or absence of cilia in the lobe axils. Another example of this problem is *Parmelina endoleuca* and *Pseudoparmelia subtiliacea* (Nylander) Hale, two very similar species in Australia that differ in the production of cilia. Both have fatty acids and cannot be separated easily by a chemical test.

Confusion may also arise with species of *Hypotrachyna* that lack cilia but may have a very dense rhizinal mat below. The mat may assume a marginal position and resemble cilia. These "cilia," however, will be dichotomously branched. Such a distinction fails in many specimens of *H. revoluta* (Floerke) Hale having rather sparsely branched rhizines and a few marginally positioned "cilia." If incorrectly interpreted as having furcate rhizines and sparse marginal cilia, such a lichen might be identified as *Parmelina cryptochlora*, which has more powdery capitate soralia, or as pustulate *P. spumosa*, which has a pale yellowish medulla. All of these species have gyrophoric acid.

One further example of parallelism involving *Parmelina dissecta* and *Hypotrachyna neodissecta* (Hale) Hale can be mentioned. The latter has clearly dichotomously branched rhizines and lacks cilia, yet both contain the same chemical, gyrophoric acid, and have virtually identical lobe configuration. It is difficult, if not impossible, to decide at this time whether intergeneric hybridization has occurred in these cases and resulted in "hybrid" species.

Rhizines.—The rhizines of *Parmelina* are of two types: simple to sparsely furcate (Figure 3*c*) and squarrose. Squarrose rhizines, that is, those with a main axis and short lateral branches, are confined mostly to some species in section *Myelochroa*. This pattern is also known in a few species of *Parmelia* (e.g., *P. sulcata* Taylor) and *Parmotrema* (the *P. reticulatum* group).

Isidia and Lobules.—Isidia are normally cylindrical and erect as in other parmelioid genera and occur in the following 13 species: *P. antillensis*, *P. expallida*, *P. dissecta* (Figure 3*d*), *P. horrescens*, *P. jamesii*, *P. indica*, *P. lindmanii*, *P. melanochaeta*, *P. obsessa*, *P. perisidians*, *P. tiliacea*, *P. usambarensis*, and *P. wallichiana*. Isidia are distinctly lobulate in *P. degelii* and *P. spathulata* (Figure 4*d*) and uniquely peltate in *P. pastillifera* (Figures 3*e*, 4*b*), a close relative of *P. tiliacea*. Apical cilia almost always occur in *P. horrescens* and *P. melanochaeta* (Figure 4*c*) and resemble those in *Parmotrema crinitum* (Acharius) Choisy.

Lobules not originating from isidia are found in *P. schindleri* and *P. xantholepis* (Figure 4*e,f*); they are mostly marginal.

Pustules.—These are characteristic of four species, *P. hayachinensis*, *P. leucotyliza* (Figure 5*g*), *P.*

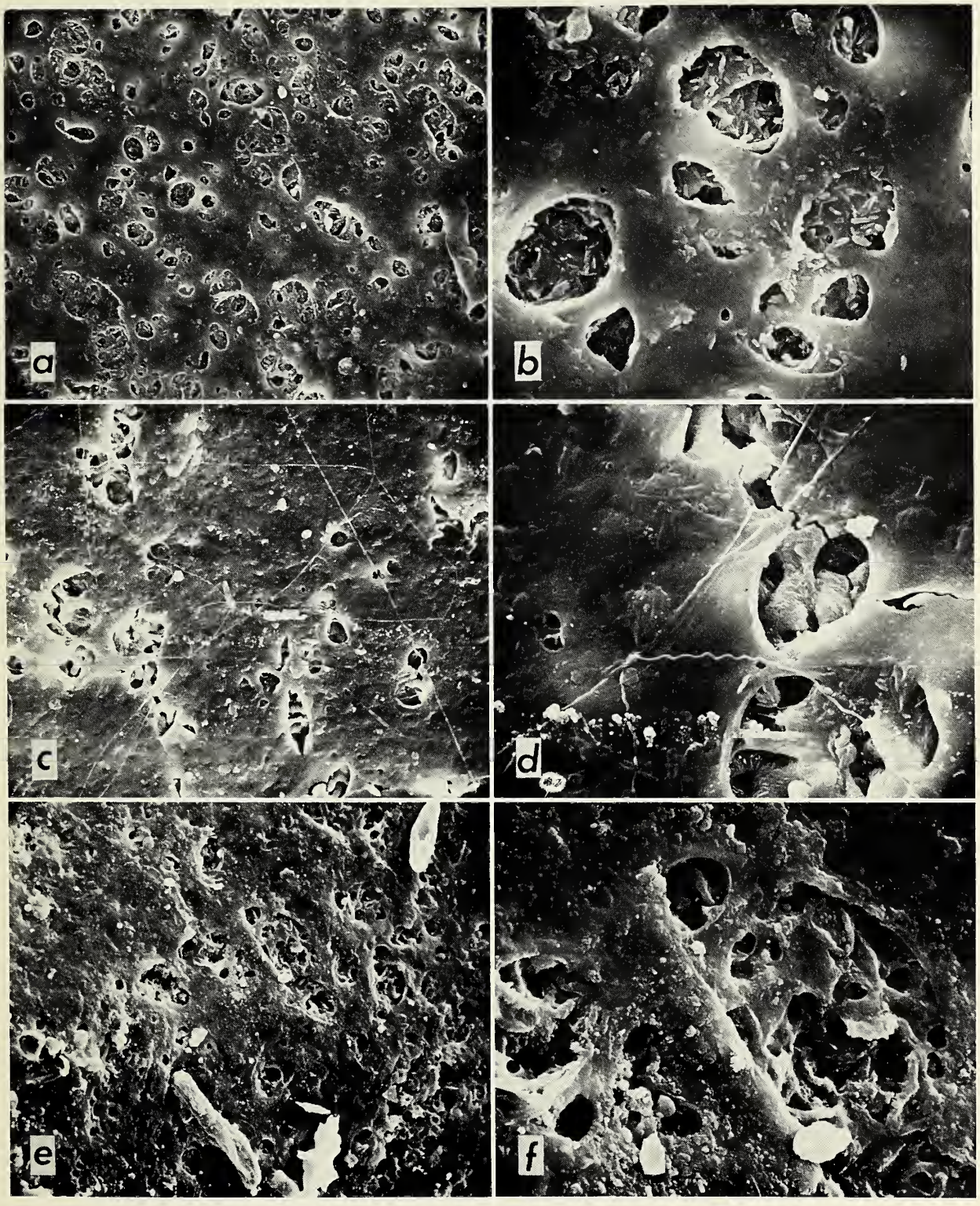

FIGURE 1.—Epicortical pores on the surface of *Parmelina* species: *a,b, P. enormis* (× 400 and 1600) (*Jellicoe* 150 in US); *c,d, P. muelleri* (× 400 and 1600) (*Hale* 42219); *e,f, P. indica* (× 400 and 1600) (*Hale* 43884). (Scanning-electron microphotographs.)

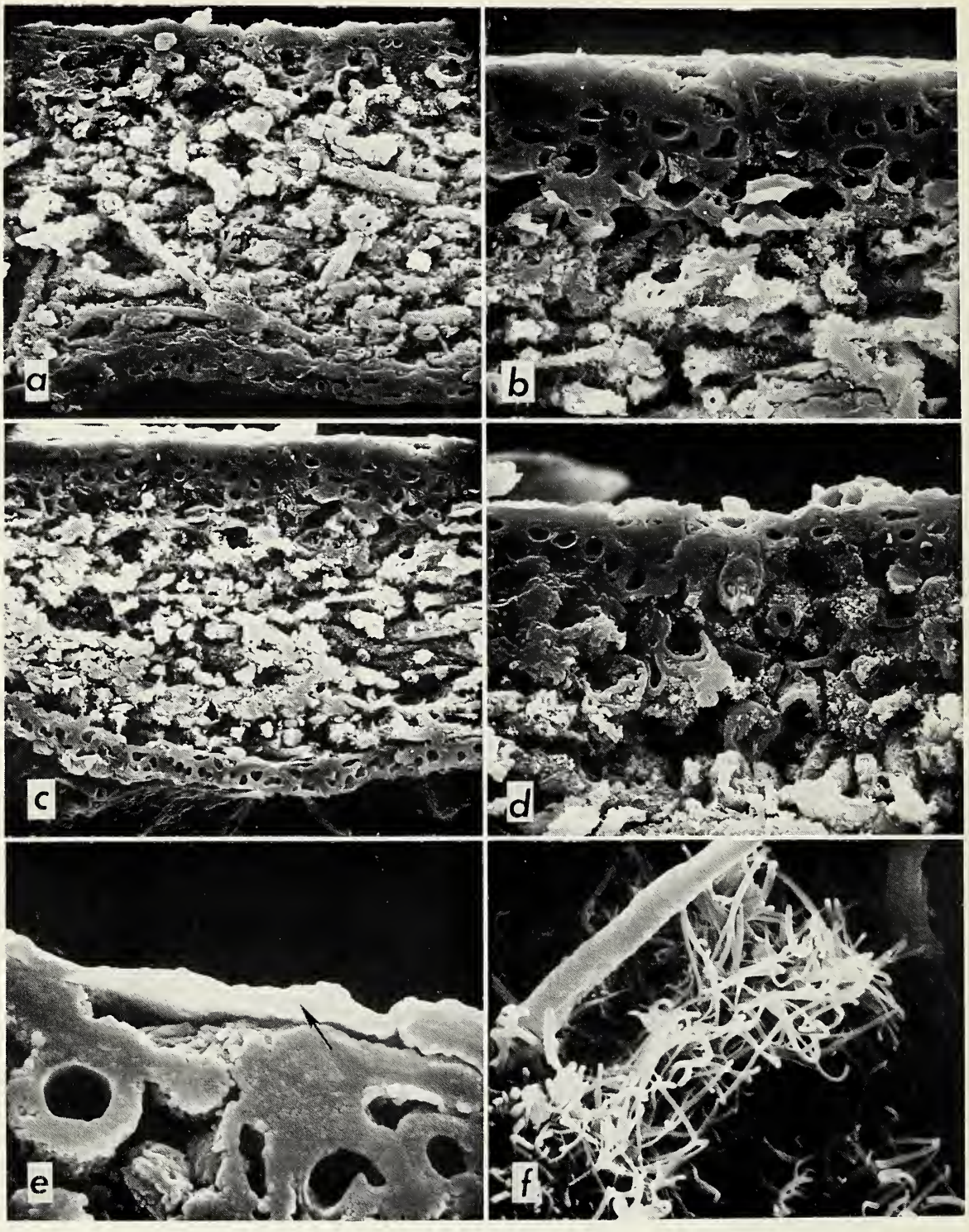

FIGURE 2.—Internal structure of *Parmelina; a,* vertical cross section of *P. degelii* (*Degelius* in US) (× 800); *b,* upper cortex of *P. degelii* (same section as in a) (× 1600); *c,* vertical cross section of *P. galbina* (*Hale* 23415) (× 800); *d,* upper cortex of *P. galbina* (same section as *d*) (× 1600); *e,* epicortex (arrow) of *P. pastillifera* (*Schröppel* 143) (× 5000); *f,* crystals of lecanoric acid on hyphae of *P. pastillifera* (*Schröppel* 143) (× 4000).

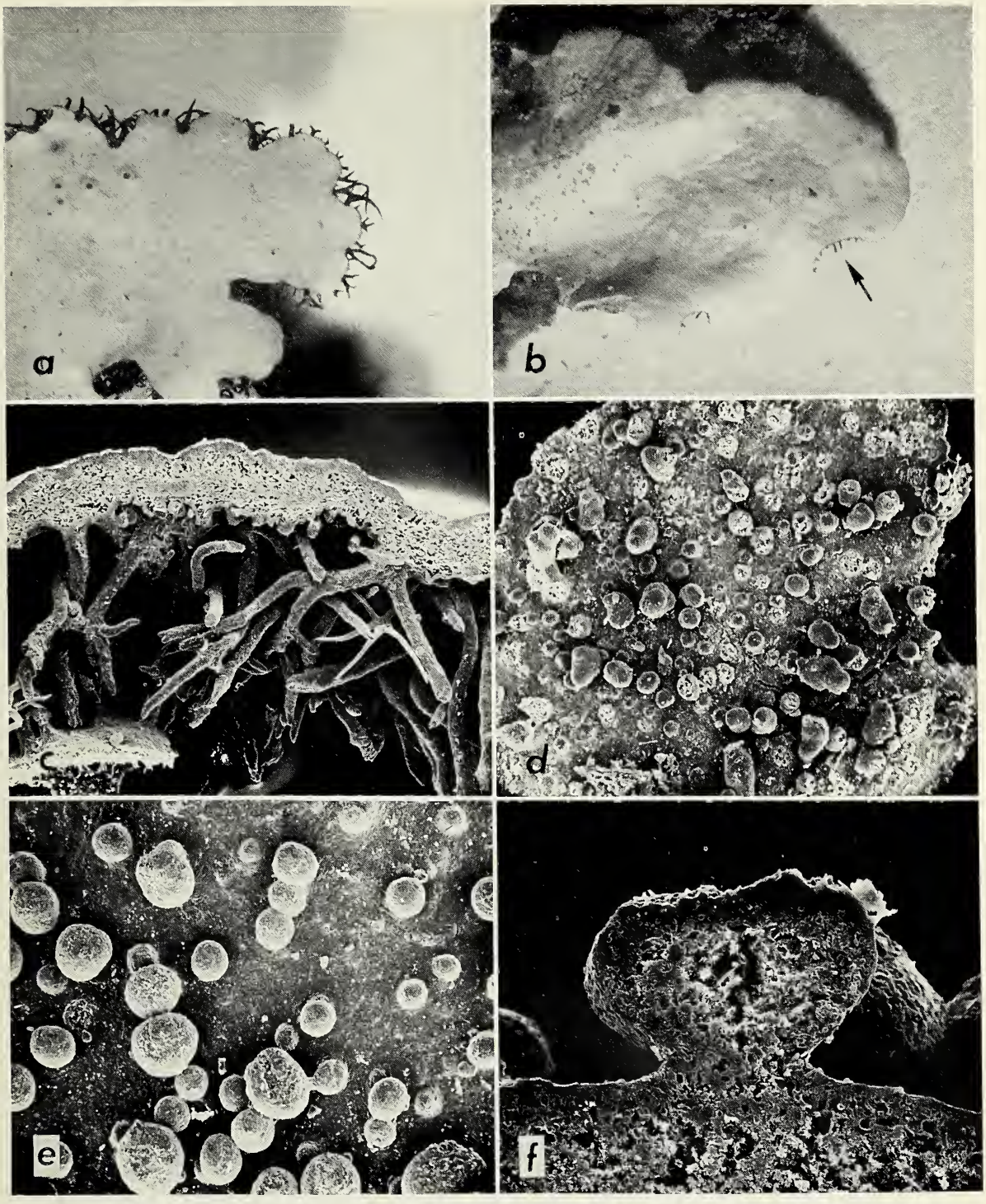

FIGURE 3.—Morphological structures of *Parmelina*: *a*, white maculae and marginal cilia of *P. consors* (*Malme* 1282 in US) (× 10); *b*, axillary cilia of *P. lindmanii* (*Nee and Mori* 4258 in US) (× 10); *c*, rhizines of *P. galbina* (*Hale* 18930) (× 70 with scanning-electron microscope); *d*, isidia of *P. dissecta* (*Montes* 10121 pro parte) (× 90 with scanning-electron microscope); *e*, peltate isidia of *P. pastillifera* (*Schröppel* 143) (× 90 with scanning electron microscope); *f*, cross-section of a peltate isidium of *P. pastillifera* (*Schröppel* 143) (× 400 with scanning-electron microscope).

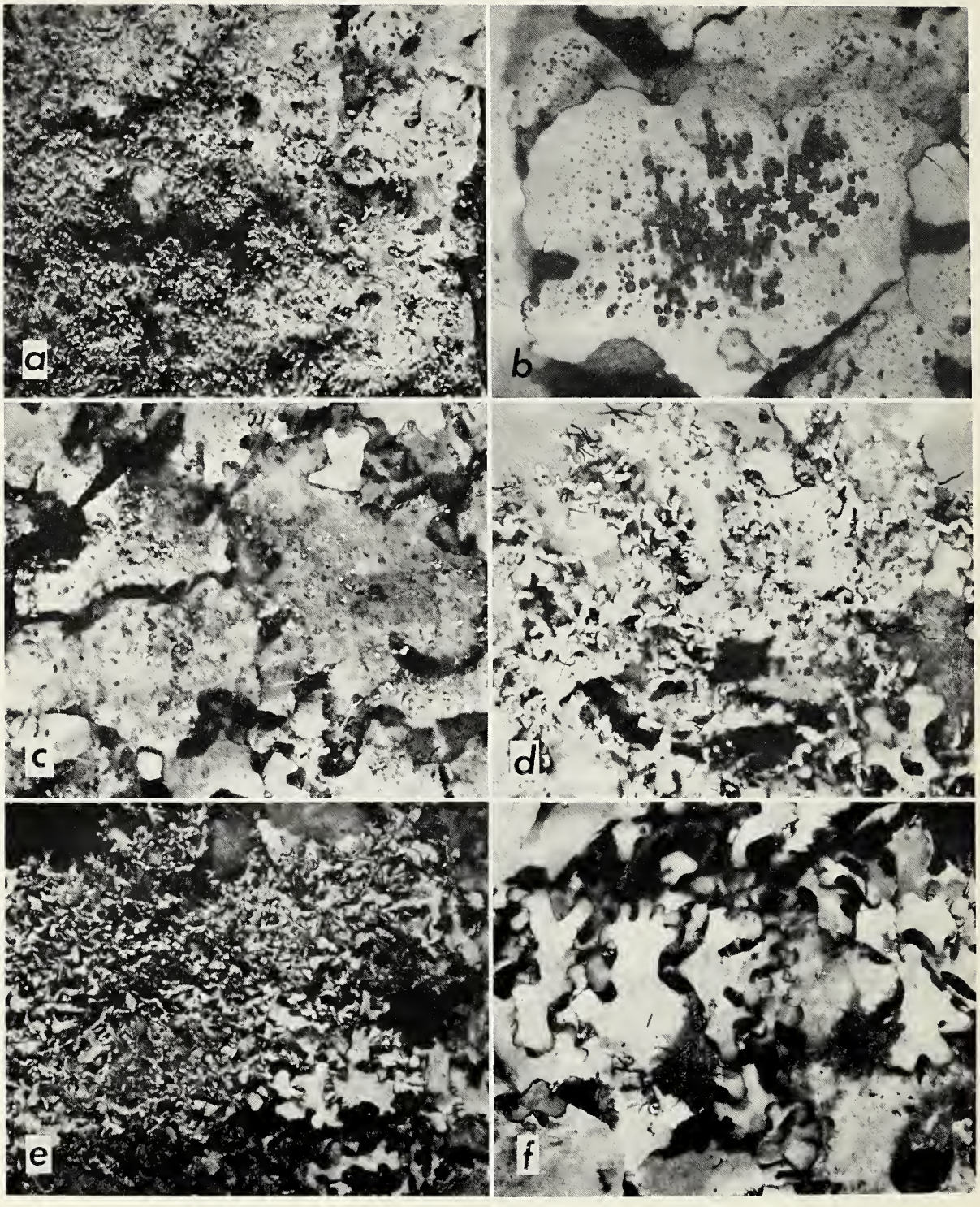

FIGURE 4.—Morphological structures of *Parmelina*: *a*, isidia of *P. dissecta* (*Hale* 33375) (× 10); *b*, peltate isidia of *P. pastillifera* (*Schroppel* 143) (× 10); *c*, ciliate isidia of *P. horrescens* (*Imshaug* 22174) (× 10); *d*, procumbent isidia of *P. spathulata* (*Koefler*, in US) (× 10); *e*, lobules of *P. schindleri* (*Schindler* 4569 in US) (× 10); *f*, lobules of *P. xantholepis* (*Hale* 25993) (× 10).

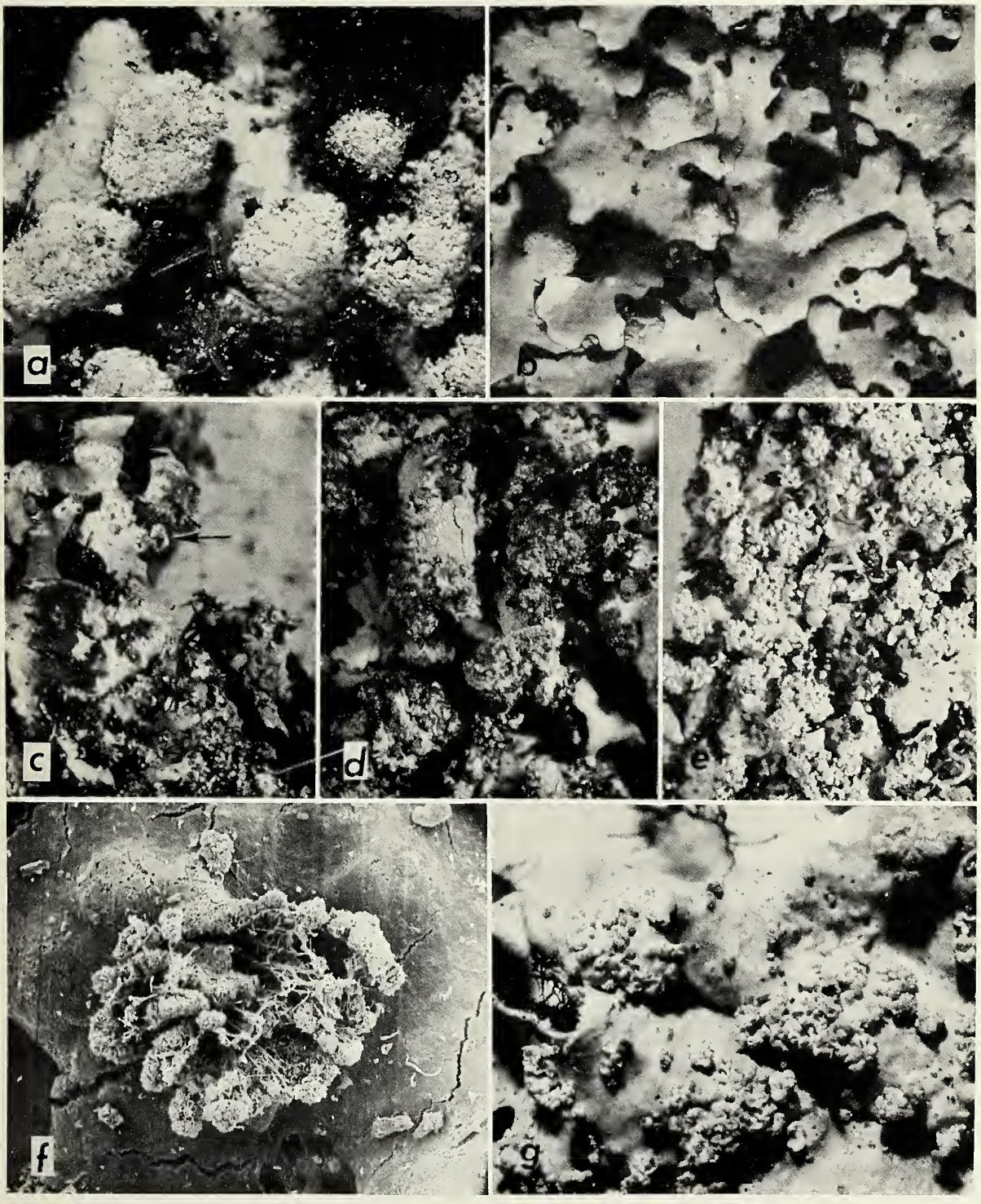

FIGURE 5.—Morphological structures of *Parmelina: a*, soralia of *P. aurulenta* (*Weber and McVean* L–51280 in US) × 10); *b*, soralia of *P. cryptochlora* (*Hale* 35357) (× 10); *c*, pustules of *P. subfatiscens* (isotype in US) (× 10); *d*, coarse soralia of *P. swinscowii* (*Swinscow* K 31/13 in US) (× 10); *e*, pustules of *P. spumosa* (*Hale* 19897) (× 10); *f*, pustule of *P. spumosa* (*Hale* 19897) (× 100 with scanning-electron microscope); *g*, pustules of *P. leucotyliza* (*Hale* 29544) (× 10).

spumosa (Figure 5*e,f*), and *P. subfatiscens* (Figure 5*c*). Soredia are not produced on these pustules. *Parmelina denegans,* on the other hand, is clearly pustulate initially but produces coarse soredia at maturity.

Soredia.—Soralia are produced in seven species of *Parmelina*: *P. aurulenta, P. cryptochlora, P. denegans, P. metarevoluta, P. muelleri, P. pilosa,* and *P. swinscowii* (Figures 5*a,b,d,* 17*b,* 18*b*). They are orbicular and laminal or subterminal but never marginal and linear as in *Parmotrema.*

The remaining 17 species of *Parmelina* produce no vegetative propagules, although the very wrinkled and often fragile upper cortex of *P. entotheiochroa* or *P. rhytidodes* might be mistaken for pustules (Figure 6).

Apothecia.—The apothecia are typically adnate or sessile and less than 5 mm in diameter, though *Parmelina irrugans* has discs up to 10 mm broad. The disc is occasionally perforate in *P. consors.* No species has a coronate rim, and only two, *P. quercina* and *P. tiliacea,* sometimes have retrorse rhizines on the lower part of the amphithecium. No fertile collections are known as yet for *P. cryptochlora, P. degelii, P. hayachinensis, P. indica, P. jamesii, P. spathulata,* or *P. swinscowii.*

Spore size is very uniform within a given species and not greatly different between unrelated species. For example, the species in the *P. dissecta–P. horrescens* group (Figure 9) have spores 8–12 × 12–18 μm. The *P. aurulenta–P. subaurulenta* group (section *Myelochroa*) has spores 5–10 × 7–15 μm. The largest spores have been measured in *P. versiformis* (10–14 × 18–28 μm), but no other species in the genus have spores greater than 19 μm long. The smallest spores (3–6 × 7–8 μm) occur in the two anamolous norstictic acid-containing species, *P. antillensis* and *P. phlyctina.*

Chemistry

The chemistry of *Parmelina* species was determined with microcrystal tests before 1965 (Hale and Kurokawa, 1964) and later with thin-layer chromatography (Merck F–254 silica gel pre-coated plates). Two solvent systems, hexane-ether-formic acid and benzene-dioxane-acetic acid, have been routinely employed using C. Culberson's methods (1972). I have had the benefit of Dr. Culberson's advice on the identification of many of the lichen substances, and she has very kindly communicated to me the results of her work on the "horrescens" unknown. It should be assumed, incidentally, that, unless otherwise stated, the components of each species in the taxonomic section refer to the holotype or lectotype specimens with additional comments on the results from other specimens.

Before listing the lichen substances discovered so far in *Parmelina,* I might point out a most remarkable feature in its chemical profile. Orcinol

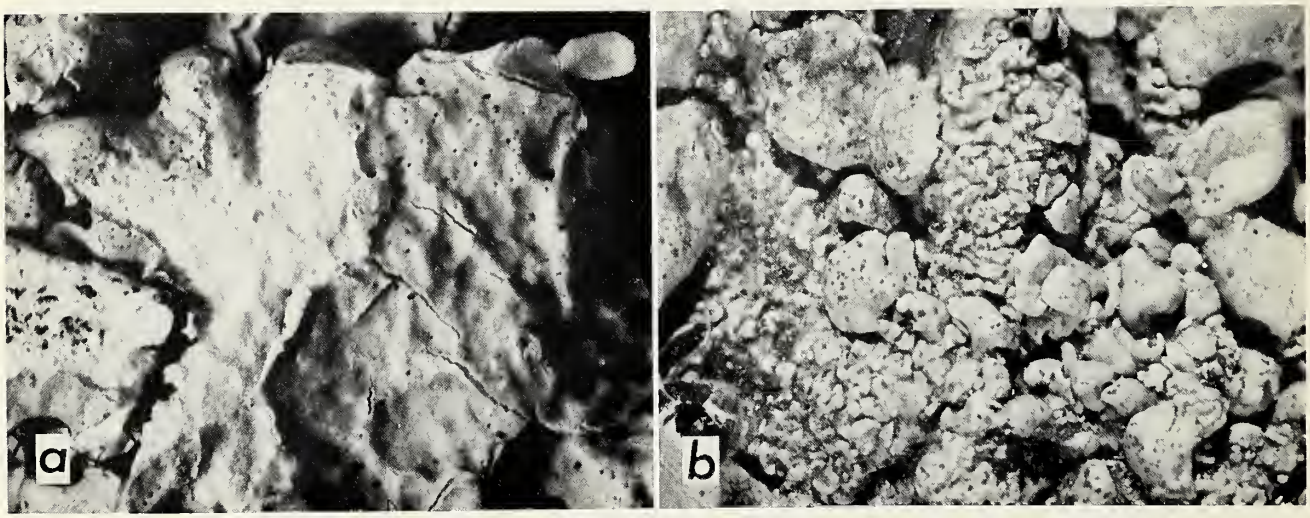

Figure 6.—Morphology of *Parmelina*: *a,* flaking cortex of *P. entotheiochroa* (*Hale* 29534) (× 4); *b,* wrinkles of *P. rhytidodes* (*Numariri* 156 in US) (× 10).

depsides (except for gyrophoric and lecanoric acids), meta-depsides, orcinol depsidones (except for rare lobaric acid), and the β–orcinol depsides related to barbatic acid are completely lacking. Two other cortical substances, lichexanthone and usnic acid, are also missing. The general impression is that *Parmelina* has a relatively "primitive" assemblage of substances and would fall on a lower evolutionary scale than *Hypotrachyna, Parmotrema,* and *Pseudoparmelia* but significantly higher than *Bulbothrix, Parmelia,* and *Relicina* (Hale, 1967).

Aliphatic Acids.—The identification of fatty acids presents many problems and no entirely satisfactory techniques have been worked out to deal with them. The most direct method is to spray the chromatographic plates with water and carefully watch for opaque, white, water-repellant spots as the plate dries. These are the fatty acids. Terpenes have a similar reaction but differ in turning bluish, purple, or brown when sprayed with H_2SO_4 and heated. Dr. Myles Keogh of the Universidad de los Andes, Merida, Venezuela, has also informed me (pers. comm.) that the fatty acids turn brownish when heated for 12 hours or more at 100°C (in contrast to the 10 minutes usually needed for development of phenolic substances). In any event, protolichesterinic acid has been identified in *P. expallida* (Kurokawa, 1968a), and unidentified fatty acids are the principle components in *P. endoleuca* and *P. heterochroa.*

Depsides.—These well-known substances are common in section *Parmelina* (those species of *Parmelina* lacking terpenes) and occur in most of the pantemperate-montane pantropical species.

Atranorin is the primary cortical substance found in all species of *Parmelina.*

Gyrophoric acid, a tridepside, occurs in *Parmelina cryptochlora, P. dissecta, P. melanochaeta, P. spathulata,* and *P. spumosa.* It is a probable minor component in *P. damaziana, P. horrescens, P. schindleri,* and *P. subfatiscens* along with the "horrescens" unknown. Gyrophoric acid is not easily chromatographed because of the tendency for streaking and variable R_f values that are highly influenced by solvent composition. In addition, one or more associated spots, still unidentified, may appear on the plates.

"Horrescens" unknown is actually several substances presumed to be depsides related to lecanoric acid. The spots react with H_2SO_4 the same as orcinol depsides and fall close to gyrophoric and lecanoric acids in the usual solvent systems. The best separation is achieved in benzene-dioxane where a single large spot, the main "horrescens" unknown, falls well above gyrophoric acid. This unknown has now been detected in *P. damaziana, P. horrescens, P. schindleri,* and *P. subfatiscens.* I have also recently discovered this substance in an undescribed species of *Hypotrachyna.*

The widespread medullary component lecanoric acid occurs in *P. pastillifera, P. pruinata, P. quercina,* and *P. tiliacea.* It falls close to gyrophoric acid on chromatographic plates and must be carefully distinguished from it by running controls. The toluene-acetic acid solvent system should be used in addition to the other two systems.

Depsidones.—These substances occur in many lichen genera but are at best sporadically developed in *Parmelina.* Phylogenetically "primitive" salazinic acid and its close acetate galbinic acid predominate in section *Parmelina.*

Constictic acid is an accessory substance with stictic acid and salazinic acid (see below).

Fumarprotocetraric acid is extremely rare in the genus, occurring in only one species, the Australian–New Zealand endemic *P. jamesii.* It is accompanied by protocetraric acid. Succinprotocetraric acid is lacking.

Galbinic acid is confined to a small group of very closely related species: *P. galbina, P. hayachinensis, P. metarevoluta,* and *P. obsessa,* accompanied by secalonic acid A and the "subaurulenta" terpene series. It is easily identified as a deep H_2SO_4 orange spot below norstictic acid in benzene-dioxane.

Lobaric acid is the only orcinol depsidone in *Parmelina* and occurs as an accessory substance with salazinic acid in *P. swinscowii.*

Norstictic acid is the main component in two closely related Caribbean species, *P. antillensis* and *P. phlyctina.* A lower spot of the, as yet, unidentified connorstictic acid may be present.

Protocetraric acid occurs only in *P. jamesii* with fumarprotocetraric acid (see above).

Salazinic acid, a very common substance in the Parmeliaceae, occurs in *P. enormis, P. simplicior, P. swinscowii, P. usambarensis, P. versiformis,* and *P. wallichiana.* It is a rare accessory with leucotylin in *P. crassata* and may be accompanied by constictic

acid in *P. metarevoluta.* All of these species, excepting *P. versiformis,* are distributed in the Old World following a pattern seen in *Bulbothrix* (Hale, 1976b).

Stictic acid has been discovered in only one species, *P. muelleri,* where it is accompanied by constictic acid and two unknown compounds falling between stictic and constictic acids in benezene-dioxane.

Terpenes.—A closely related series of triterpenes with a hopane skeleton have been described for species in section *Myelochroa.* Their structures have been determined by Yosioka and his group in Japan using nuclear magnetic resonance (NMR) spectra, mass spectrometry, etc. The thin-layer chromatography is not yet standardized or well understood, and I have not tried to identify individual spots. Typical profiles for the terpene-containing species of *Parmelina* are illustrated in Figure 7.

Leucotylic acid, a colorless compound closely related to both zeorin and leucotylin, was first elucidated by Yosioka (1966). It was isolated from *Parmelina leucotyliza,* although my results indicate that leucotylin is, in fact, the main component of this species. I suspect that their material included a mixture of *P. crassata,* which does contain leucotylic acid. The species of *Parmelina* which contain leucotylic acid (or at least have the same terpenic profile as *P. aurulenta,* as illustrated in Figure 7) are *P. aurulenta, P. degelii, P. irrugans,* and *P. rhytidodes.*

Leucotylin, the progenitor of leucotylic acid, is the main terpene component in *P. amagiensis, P. crassata, P. denegans, P. entotheiochroa, P. galbina, P. hayachinensis, P. indica, P. leucotyliza, P. metarevoluta, P. obsessa, P. perisidians, P. subaurulenta,* and *P. xantholepis.* It forms a low major spot in benzene-dioxane, but I have generally identified it as a profile of several terpene spots as illustrated in Figure 7.

Yosioka (Yosioka and Nakanishi, 1963; Yosioka and Nakanishi, 1966) has isolated at least five other compounds related to leucotylin in "Parmelia entotheiochroa." I presume that at least some of these make up the numerous spots resolved in hexane-ether (see Figure 7), but no attempt has been made to identify any of them on the plates. There seems to be great variation in the intensity of the spots, reflecting different concentrations in the thallus. It remains to be seen whether this variation has any taxonomic value.

Zeorin is a well known lichen substance. The stereochemistry of its hopane skeleton was only recently studied by Yosioka et al. (1968b). It occurs in all species in section *Myelochroa* and has been reported in *Acroscyphus, Cladonia* spp., *Hypotrachyna majoris* (Vainio) Hale, *Lecanora, Nephroma, Peltigera,* and the Physciaceae. It may be identified as the highest blue spot on the chromatographic plates in both solvent systems (Figure 7).

Pigments.—Medullary pigments are especially characteristic of species in section *Myelochroa.* The chromatography of these is extremely difficult and usually unsuccessful. There is considerable streaking and individual components cannot be distinguished.

Secalonic acid A was first identified by Yosioka et al. (1968a:2090), who established its identity with entothein. It also occurs in ergot (Shibata et al., 1964). Yosioka found secalonic acid A in *Parmelina aurulenta, P. entotheiochroa, P. perisidians,* and *P. subaurulenta,* and I presume it is the major pigment in all species of section *Myelochroa* with a yellowish orange medulla, as well as in *P. immiscens* and *P. lindmanii,* both lacking terpenes. Unidentified reddish pigments accompany secalonic acid A in the lower medullary layer of *P. amagiensis* and *P. denegans.*

Phytogeography and Speciation

Parmelina occurs primarily on trees in secondary forests in temperate zones and at higher elevations in the tropics. A number of the commoner species may also occur on rocks. There are, however, only four obligately saxicolous species, *P. enormis, P. indica, P. obsessa,* and *P. usambarensis.* The *Parmelina* floras of various geopolitical units are enumerated below. It is altogether obvious that many countries are underrepresented because they have not been visited by lichen collectors.

North America

United States: *P. antillensis, P. aurulenta, P. dissecta, P. galbina, P. horrescens, P. metarevoluta, P. obsessa,* and *P. spumosa.*

Mexico and Central America

Mexico: *P. antillensis, P. aurulenta, P. dissecta, P. hor-*

rescens, P. immiscens, P. lindmanii, P. muelleri, and *P. spumosa.*

Guatemala: *P. horrescens.*

Panama: *P. dissecta, P. horrescens,* and *P. subfatiscens.*

West Indies

Cuba: *P. antillensis, P. dissecta, P. horrescens,* and *P. phlyctina.*

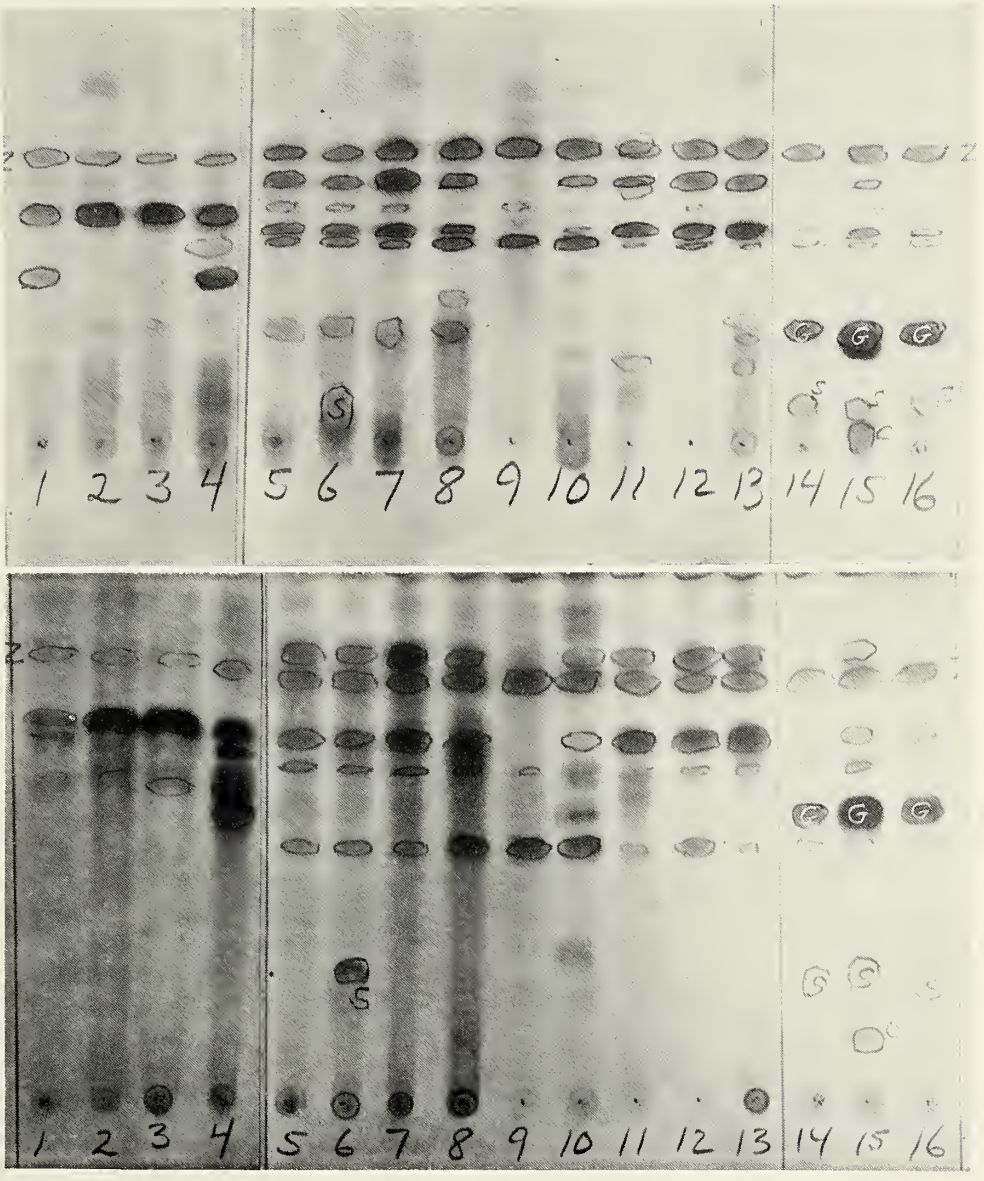

FIGURE 7.—Chromatographic profiles of *Parmelina* species: profiles in the hexane-ether solvent system (top) and benzene-dioxane solvent system (bottom). (1 = *P. aurulenta,* 2 = *P. degelii,* 3 = *P. irrugans,* 4 = *P. rhytidodes,* 5 = *P. amagiensis,* 6 = *P. crassata,* 7 = *P. denegans,* 8 = *P. entotheiochroa,* 9 = *P. indica,* 10 = *P. leucotyliza,* 11 = *P. perisidians,* 12 = *P. subaurulenta,* 13 = *P. xantholepis,* 14 = *P. galbina,* 15 = *P. metarevoluta,* 16 = *P. obsessa,* Z = zeorin spot, G = galbinic acid, S = salazinic acid, and C = constictic acid; leucotylic acid is presumed to be the series of spots in 1 to 4 just below zeorin, and leucotylin is the lowest series in 5–10 in benzene-dioxane; atranorin falls just above the point where the photographs were trimmed.)

Jamaica: *P. antillensis, P. dissecta, P. horrescens, P. phlyctina, P. spumosa,* and *P. subfatiscens.*

Hispaniola: *P. antillensis, P. dissecta, P. horrescens,* and *P. phlyctina.*

Puerto Rico: *P. phlyctina.*

Lesser Antilles (including Trinidad): *P. antillensis, P. cryptochlora, P. dissecta,* and *P. subfatiscens.*

South America

Colombia: *P. lindmanii, P. melanochaeta,* and *P. spumosa.*

Venezuela: *P. antillensis, P. dissecta, P. horrescens, P. lindmanii, P. muelleri,* and *P. spumosa.*

Ecuador: *P. pilosa.*

Peru: *P. muelleri.*

Brazil: *P. antillensis, P. aurulenta, P. consors, P. damaziana, P. dissecta, P. heteroloba, P. lindmanii, P. melanochaeta, P. muelleri, P. schindleri, P. spumosa,* and *P. versiformis.*

Uruguay: *P. consors, P. horrescens, P. lindmanii,* and *P. pilosa.*

Paraguay: *P. consors, P. lindmanii,* and *P. melanochaeta.*

Argentina: *P. consors, P. lindmanii, P. muelleri, P. pilosa,* and *P. versiformis.*

Chile: *P. horrescens, P. pilosa, P. spumosa,* and *P. swinscowii.*

Europe

Western Europe: *P. dissecta, P. horrescens, P. pastillifera, P. quercina,* and *P. tiliacea.*

Russia: *P. aurulenta, P. quercina,* and *P. tiliacea.*

Israel: *P. tiliacea.*

Africa

Morocco: *P. tiliacea.*

Tunisia: *P. tiliacea.*

Ivory Coast: *P. usambarensis* and *P. wallichiana.*

Guinea: *P. usambarensis* and *P. wallichiana.*

Uganda: *P. usambarensis* and *P. wallichiana.*

Kenya: *P. dissecta, P. pilosa, P. swinscowii,* and *P. wallichiana.*

Angola: *P. wallichiana.*

Rhodesia: *P. wallichiana.*

Zambia: *P. enormis.*

Tanzania: *P. aurulenta, P. dissecta, P. usambarensis,* and *P. wallichiana.*

Union of South Africa (including Swaziland): *P. dissecta, P. horrescens, P. pilosa, P. spathulata, P. spumosa, P. subfatiscens,* and *P. wallichiana.*

Madagascar-Réunion: *P. aurulenta, P. spumosa,* and *P. wallichiana.*

Asia and Pacific Areas

Pakistan: *P. aurulenta, P. quercina,* and *P. tiliacea.*

India (including Nepal): *P. aurulenta, P. cryptochlora, P. denegans, P. dissecta, P. expallida, P. horrescens, P. indica, P. perisidians, P. rhytidodes, P. simplicior, P. spumosa, P. subaurulenta, P. tiliacea, P. wallichiana,* and *P. xantholepis.*

Sri Lanka: *P. denegans, P. dissecta, P. perisidians,* and *P. subaurulenta.*

Thailand: *P. expallida, P. perisidians, P. usambarensis, P. wallichiana,* and *P. xantholepis.*

Indochina: *P. aurulenta.*

China (including Hong Kong): *P. aurulenta, P. irrugans, P. quercina, P. subaurulenta,* and *P. wallichiana.*

Korea: *P. entotheiochoroa.*

Japan: *P. amagiensis, P. aurulenta, P. crassata, P. dissecta, P. entotheiochroa, P. galbina, P. hayachinensis, P. horrescens, P. irrugans, P. leucotyliza, P. metarevoluta, P. perisidians, P. quercina, P. rhytidodes, P. spumosa,* and *P. wallichiana.*

Taiwan: *P. aurulenta, P. dissecta, P. expallida, P. horrescens, P. spumosa, P. subaurulenta,* and *P. wallichiana.*

Philippines: *P. aurulenta, P. dissecta, P. horrescens, P. perisidians, P. wallichiana,* and *P. xantholepis.*

Malaya: *P. wallichiana.*

Indonesia: *P. aurulenta, P. dissecta, P. horrescens, P. spumosa, P. wallichiana,* and *P. xantholepis.*

Sabah: *P. denegans, P. leucotyliza,* and *P. wallichiana.*

New Guinea: *P. aurulenta.*

Australia (including New Zealand): *P. degelii, P. endoleuca, P. horrescens, P. jamesii, P. pruinata, P. quercina,* and *P. spumosa.*

Hawaiian Islands: *P. aurulenta.*

To summarize, the New World has a total flora of 20 species, 12 of them endemic, 3 (*P. pilosa, P. subfatiscens,* and *P. swinscowii*) shared with Africa, and the remaining 5 (*P. aurulenta, P. dissecta, P. horrescens, P. quercina,* and *P. spumosa*) essentially pantemperate or montane pantropical.

Europe has a small *Parmelina* flora. Dahl and Krog (1973) list only *P. tiliacea* in Scandinavia. The checklist by James (1965) for Great Britain includes *P. dissecta, P. horrescens, P. quercina,* and *P. tiliacea.* For the rest of Europe, Poelt (1969) adds only *P. carporrhizans* (=*P. quercina*) and *P. pastillifera.*

Africa has only two endemic species, *P. enormis* and *P. spathulata,* and nine other species either shared with the Americas, Asia, or pantemperate in distribution.

Asia is especially rich in *Parmelina* with 15 species on the Indian subcontinent and 16 in Japan and eastern Asia. Tropical Southeast Asia has nine species, none of them endemic and all occurring in the higher elevation cloud forests. The genus is not represented at all in the lowland dipterocarp rain forests from Sri Lanka to Indonesia.

The Australia–New Zealand region has seven species, of which four, *P. degelii, P. endoleuca, P. jamesii,* and *P. pruinata,* are endemic. No *Parme-*

FIGURE 8.—Number of species in section *Myelochroa* in each major geographical division.

linae have been collected on the Pacific Islands except for *P. aurulenta* at higher elevations in Hawaii. The total Old World flora (Africa, Asia, and Australia–New Zealand) comprises 26 species.

One distribution pattern of considerable phytogeographic interest stands out. The species of section *Myelochroa,* a rather homogeneous group, are concentrated in India and eastern Asia (Figure 8) and only one of them, *P. aurulenta,* occurs in all geographic areas (Figure 10). The species in section *Parmelina,* on the other hand, are not strongly concentrated in any region.

Within section *Myelochroa* the species related to *P. galbina* form a particularly interesting group. As pointed out by Kurokawa (1972), *P. galbina,* the fertile progenitor species, behaves as an Arctotertiary plant which migrated southward and has survived in Japan and eastern North America. A rare sorediate morph, *P. metarevoluta,* has the same range, whereas the isidiate morph, *P. obsessa,* is restricted to North America, and the pustulate morph, *P. hayachinensis,* to Japan. W. Culberson (1972) also regards *P. aurulenta* as a Tertiary relict.

Parmelina has several complex groups of species that have evidently resulted from combined chemical and morphological evolution. The species in section *Myelochroa,* for example, all of which contain terpenes and almost always have secalonic acid A, a yellow pigment, have evolved from two chemically dissimilar ancestors, one, the smaller group, with leucotylic acid and resembling *P. irrugans,* and the other, a larger series with leucotylin, resembling the present-day *P. subaurulenta.* The numerous morphs derived from these presumptive parents or their ancestors, *P. amagiensis, P. aurulenta, P. crassata, P. degelii, P. denegans, P. entotheiochroa, P. leucotyliza, P. perisidians, P. rhytidodes, and P. xantholepis,* have diversified mostly by production of soredia, isidia, pustules, and wrinkles, variation in apothecial diameter, etc. Morph formation (see Hale, 1975a:13) is not strongly delineated for the most part since the parents cannot be traced directly. We are left to conclude that section *Myelochroa* is an ancient group

evolved over a long period. The *P. galbina* group, as mentioned above, forms the only exception to this rule.

Morph formation has also been an important mode of speciation in section *Parmelina*. The following parent morph–vegetative morph series are indisputable: *P. consors–P. pilosa* (sorediate), *P. quercina–P. tiliacea* (isidiate), and *P. immiscens–P. lindmanii* (isidiate). *Parmelina phlyctina* and isidiate *P. antillensis* are extremely close but less clear-cut morphs. A large complex of species have been derived from now extinct parents in the *P. dissecta–P. horrescens group*, as illustrated in Figure 9. Like the *P. subaurulenta* group of section *Myelochroa*, the parent morphs of these numerous vegetative morphs are either extinct or have yet to be discovered.

The remaining species in the genus appear to have no discernible interrelationships or morphs. These include *P. endoleuca, P. enormis, P. expallida, P. heteroloba* (part of the *P. damaziana* series?), *P. pruinata, P. simplicior, P. swinscowii, P. usambarensis, P. versiformis,* and *P. wallichiana.*

Classification of *Parmelina*

The taxon *Lichen* section *Imbricaria* was first proposed by Schreber (1791:767). He cited no species, only *Squamaria* Hoffmann, which is invalid as the later homonym of *Squamaria* Ludwig (Phanerogamae). Acharius (1794:250) adopted the name as a tribe of *Lichen* and included in it *L. olivaceus* L. and *L. tiliaceus* Hoffmann, as well as several other species now recognized as belonging to *Hypogymnia, Parmeliopsis, Physcia,* and *Xanthoria.* Michaux (1803) raised the name to generic rank and cited one species, a lichen now called *Anzia colpodes* (Acharius) Stizenberger. Fries (1825:242) later transferred it to *Parmelia* as *Parmelia* section *Imbricaria,* and Koerber (1855:68) used it at the generic rank, even though he realized that the name was a later homonym of *Imbricaria* Decandolle (Phanerogamae). Koerber and contemporary lichenologists placed many species that we now consider parmelioid in *Imbricaria,* while at the same time using *Parmelia* for many species now placed in *Physcia.*

After the delimitation of *Parmelia* in a modern sense by authors such as Müller and Nylander, *Imbricaria* was relegated to synonymy under it. Hale and Kurokawa (1964:130) grouped the narrow-lobed, marginally ciliate *Parmeliae* in *Parmelia* subgenus *Parmelia* section *Imbricaria* (Schreber) E. Fries, and it is essentially this group that I have segregated as a distinct genus, *Parmelina* (Hale, 1974: 482).

Parmelina is a rather heterogeneous assemblage of 47 species differing in lobe width, production of cilia, pigmentation, and rhizine branching. Two major groups can be recognized, one including those species lacking terpenes and one with terpene-containing species. They may be conveniently regarded as sections.

Section *Parmelina*

Parmelia section *Hypotrachyna* subsection *Myeloleuca* Asahina, 1952:74 [type-species: *Parmelina tiliacea* (Hoffmann) Hale].

The species in this section are characterized by the lack of any triterpenes. Except for two species, *P. immiscens* and *P. lindmanii,* the medulla is white and unpigmented. Several internally homogeneous groups can be recognized. For example, the *P. dissecta–P. horrescens* group (Figure 9) includes seven species with very similar lobe configuration, abundant marginal cilia, and gyrophoric acid or the closely related "horrescens" unknown. Heavily white-maculate *P. consors, P. pilosa,* and *P. muelleri,* having coarse, leathery thalli and thick, furcate marginal cilia, are obviously related.

The predominantly European complex of species, *P. quercina–P. tiliacea–P. pastillifera,* contains lecanoric acid and forms an easily recognized but isolated group. *Parmelina antillensis* and *P. phlyctina,* both unusual in containing norstictic acid, have no close relatives in the genus. Two other New World species, *P. immiscens* and *P. lindmanii* with a yellow medulla, form an isolated branch of this section.

The species with salazinic acid, *P. enormis, P. simplicior, P. swinscowii, P. usambarensis, P. versiformis,* and *P. wallichiana,* have little in common except their chemistry. Finally, the remaining species, *P. endoleuca, P. expallida, P. heteroloba, P. jamesii,* and *P. pruinata,* have no obvious common ancestry or affinities with other species in the section.

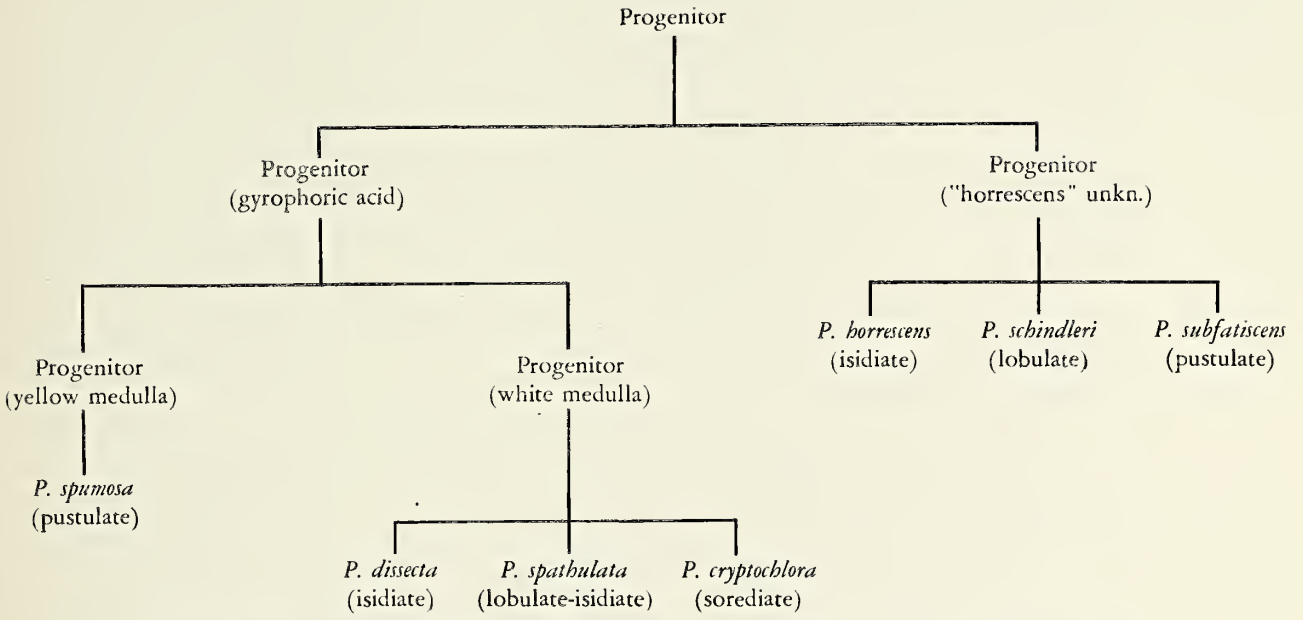

FIGURE 9.—Hypothetical derivation of species in the *Parmelina dissecta–P. horrescens* group. Not shown are *P. damaziana,* a presumptive nonisidiate, nonsorediate derivative of the "horrescens" progenitor, and *P. melanochaeta,* a possible relative of *P. dissecta* but derived from a different progenitor.

Section *Myelochroa* (Asahina) Hale, new status

Parmelia section *Hypotrachyna* subsection *Myelochroa* Asahina, 1952:74 [type-species: *Parmelina aurulenta* (Tuckerman) Hale].

All of the species in this section contain zeorin and either leucotylin or leucotylic acid and associated terpenes, and all, excepting *P. indica,* produce varying amounts of the yellow-orange pigment secalonic acid A and possibly other, as yet, unidentified pigments. This group is highly restricted to Asia, and the 17 species have very close affinities, in sharp contrast to section *Parmelina.*

Two apparently unrelated groups are recognizable in the section. One, the *P. galbina* group (*P. galbina, P. hayachinensis, P. metarevoluta,* and *P. obsessa),* is characterized by galbinic acid in addition to leucotylin and secalonic acid A. The other group includes two closely related subgroups, the *P. aurulenta* subgroup (*P. aurulenta, P. degelii, P. irrugans,* and *P. rhytidodes)* with leucotylic acid, and the *P. subaurulenta* subgroup (*P. amagiensis, P. crassata, P. denegans, P. entotheiochroa, P. leucotyliza, P. perisidians, P. subaurulenta, and P. xantholepis)* with leucotylin. *Parmelina indica* can probably be classified in the *P. subaurulenta* subgroup although it has a small saxicolous thallus and lacks secalonic acid A.

The affinities of *Parmelina* lie primarily with *Parmotrema* Massalongo, a broader lobed, loosely attached, often ciliate genus (Hale, 1965). *Parmelina,* however, has a far less evolved chemistry, narrower adnate lobes, consistently small spores, and adnate or sessile, usually imperforate apothecia. Where soredia are produced, they are laminal rather than marginal in contrast to most *Parmotrema* species. All in all, however, the apparent intergradation between broad-lobed *Parmelinae* and the smaller lobed species of *Parmotrema,* involving perhaps six or eight species, poses difficult problems in the correct generic identification of individual specimens and for the "lumper," at least, raises questions on the distinctness of the two genera as circumscribed here. I do not expect that the problem can be resolved to the satisfaction of all lichenologists, but the basic differences should become clearer as more collections are made in tropical

countries and our knowledge of soredial formation, significance of chemical variation, etc., broadens.

The key below is divided into three sections: (1) species lacking isidia, soredia, and pustules; (2) those with isidia, lobulate isidia, or lobules; and (3) those with soredia or pustules.

Key to the Species of *Parmelina*

I. Thallus Lacking Isidia, Soredia, and Pustules

(Cortex flaking off in *Parmelina entotheiochroa* and *P. phlyctina*, and heavily rugose in *P. crassata* and *P. rhytidodes*)

1. Medulla more or less completely yellow to yellow-orange (pigmented mostly below the apothecia in *P. galbina*).
   2. Upper surface heavily rugose (Figure 6*b*) ..... 35. ***P. rhytidodes***
   2. Upper surface more or less plane.
      3. Upper cortex very fragile, flaking away over extensive areas (Figure 6*a*).
         4. Medulla deep yellow ..... 13. ***P. entotheiochroa***
         4. Medulla white (turning reddish if improperly curated) ..... 31. ***P. phlyctina***
      3. Upper cortex entire and continuous.
         5. Lower half of medulla darker reddish orange ..... 1. ***P. amagiensis***
         5. Lower half of medulla not darkly pigmented.
            6. Lobes narrow and sublinear, 1–2 mm wide ..... 15. ***P. galbina***
            6. Lobes broader, subirregular, 2–4 mm wide.
               7. Collected in Mexico ..... 19. ***P. immiscens***
               7. Collected in Asia.
                  8. Apothecia 3 mm or less in diameter ..... 40. ***P. subaurulenta***
                  8. Apothecia 3–10 mm in diameter.
                     9. Thallus coarse, about 250 μm thick: leucotylin present ..... 5. ***P. crassata***
                     9. Thallus membranous, about 150 μm thick; leucotylic acid present ..... 21. ***P. irrugans***

1. Medulla entirely white.
   10. Lower surface pale brown.
      11. Collected on rocks in Africa ..... 12. ***P. enormis***
      11. Collected in trees in South America ..... 45. ***P. versiformis***
   10. Lower surface black.
      12. Medulla K+ yellow turning red.
         13. Lobes sublinear, 1–2 mm wide ..... 15. ***P. galbina***
         13. Lobes broader, 2–5 mm wide.
            14. Upper cortex fragile, flaking off ..... 31. ***P. phlyctina***
            14. Upper cortex firm, continuous.
               15. Collected in India ..... 37. ***P. simplicior***
               15. Collected in South America ..... 45. ***P. versiformis***
      12. Medulla K negative.
         16. Medulla C+ red.
            17. Cortex distinctly white maculate ..... 34. ***P. quercina***
            17. Cortex emaculate ..... 33. ***P. pruinata***
         16. Medulla C−.
            18. Thallus coriaceous, heavily white-maculate; lobes 2–5 mm wide ..... 4. ***P. consors***
            18. Thallus thin, emaculate; lobes 1–3 mm wide.
               19. Medulla KC+ rose; "horrescens" unknown present ..... 7. ***P. damaziana***
               19. Medulla KC−; fatty acids present.
                  20. Collected in Australia ..... 11. ***P. endoleuca***
                  20. Collected in South America ..... 17. ***P. heteroloba***

II. Thallus Isidiate, Lobulate-Isidiate, or Lobulate

1. Medulla yellow to pale orange-yellow.

2. Thallus densely lobulate without formation of isidial initials (Figure 4*f*) ..... 47. ***P. xantholepis***
2. Thallus normally isidiate or lobulate-isidiate.
3. Isidia large, dorsiventral and lobulate ..... 8. ***P. degelii***
3. Isidia normal, cylindrical and erect.
4. Lobes subirregular and apically rotund, 3–6 mm wide ..... 24. ***P. liudmanii***
4. Lobes sublinear, 1–2 mm wide.
5. Plants saxicolous (rarely corticolous) in eastern North America ..... 28. ***P. obsessa***
5. Plants corticolous in Southeast Asia ..... 30. ***P. perisidians***

1. Medulla white.
6. Thallus densely lobulate without isidial initials (Figure 4*e*) ..... 36. ***P. schindleri***
6. Thallus isidiate or lobulate-isidiate.
7. Isidia in part procumbent and lobulate (Figure 4*c,d*).
8. Medulla C+ rose ..... 38. ***P. spathulata***
8. Medulla C− ..... 18. ***P. horrescens***
7. Isidia erect, cylindrical.
9. Medulla K+ yellow turning red.
10. Collected in tropical America; norstictic acid present ..... 2. ***P. antillensis***
10. Collected in Asia and Africa; salazinic acid present.
11. Lobes subirregular, crowded, apically rotund ..... 46. ***P. wallichiana***
11. Lobes sublinear, loosely divaricate ..... 44. ***P. usambarensis***
9. Medulla K− or faintly yellow.
12. Medulla C+ rose or red.
13. Isidia apically flattened and peltate ..... 29. ***P. pastillifera***
13. Isidia cylindrical, not peltate.
14. Medulla C+ intense red (lecanoric acid) ..... 43. ***P. tiliacea***
14. Medulla C+ rose (gyrophoric acid).
15. Lobes narrow, 1–2 mm wide; upper surface emaculate; isidia eciliate ..... 10. ***P. dissecta***
15. Lobes broader, 2–6 mm wide; upper surface maculate; isidia ciliate ..... 25. ***P. melanochaeta***
12. Medulla C−.
16. Medulla P+ red ..... 22. ***P. jamesii***
16. Medulla P−.
17. Lower surface brown to blackening in part ..... 14. ***P. expallida***
17. Lower surface uniformly black.
18. Isidia apically ciliate; medulla KC+ rose ..... 18. ***P. horrescens***
18. Isidia eciliate; medulla KC− ..... 20. ***P. indica***

III. Thallus Sorediate, Sorediate-Pustulate, or Pustulate

1. Medulla entirely white.
2. Lobes broad and apically rotund; cortex conspicuously white-maculate (Figure 3*a*).
3. Medulla K+ yellow (stictic acid) ..... 27. ***P. muelleri***
3. Medulla K− ..... 32. ***P. pilosa***
2. Lobes narrower and sublinear, apically obtuse.
4. Medulla C+ rose (gyrophoric acid).
5. Rhizines simple ..... 6. ***P. cryptochlora***
[5. Rhizines furcate to dichotomously branched, marginal cilia lacking ..... ***Hypotrachyna revoluta*** (Floerke) Hale]
4. Medulla C−.
6. Medulla K+ yellow to red (salazinic acid) ..... 42. ***P. swinscowii***
6. Medulla K negative ("horrescens" unknown) ..... 41. ***P. subfatiscens***

1. Medulla entirely or partially yellow to yellow-orange (at least pigmented below the soralia).
7. Upper cortex flaking off without formation of soredia (Figure 6*a*) ..... 13. ***P. entotheiochroa***
7. Upper cortex entire, soredia or pustules present.
8. Thallus pustulate without formation of soredia (Figure 5*e,f*).
9. Lobes rather broad, subirregular, 2–4 mm wide.

10. Pustules forming in capitate masses (Figure 5*g*) ..... 23. ***P. leucotyliza***
10. Pustules irregular, intermixed with wrinkles (Figure 6*b*) ..... 35. ***P. rhytidodes***
9. Lobes narrow and sublinear, less than 2 mm wide.
11. Medulla K+ reddish, P+ orange ..... 16. ***P. hayachinensis***
11. Medulla K−, P−, C+ rose, pigmented very faint yellow ..... 39. ***P. spumosa***
8. Thallus sorediate or pustulate-sorediate at maturity.
12. Medulla deeper reddish orange in the lower half ..... 9. ***P. denegans***
12. Medulla uniformly pigmented to white and pigmented only under the soralia.
13. Lobes 2–4 mm wide; medulla P− ..... 3. ***P. aurulenta***
13. Lobes less than 2 mm wide; medulla P+ orange ..... 26. ***P. metarevoluta***

Species Treatment

The 47 species of *Parmelina* are arranged below in alphabetical order. Location of specimens listed under "Specimens Examined" are indicated by the standard herbarium acronyms except for those collected by Hale, all of which are preserved in the Smithsonian Institution (US).

1. *Parmelina amagiensis,* new combination

FIGURE 11*a*

Parmelia amagiensis Asahina, 1951a:228 [type collection: Mt. Amagi, Prov. Izu, Japan, *Asahina* 95 (TNS, lectotype)].

DESCRIPTION.—Thallus loosely adnate on bark or mosses over bark, buff mineral gray, 4–8 cm broad; lobes more or less subirregular, imbricate, 2–3 mm wide, the marginal cilia numerous, simple, up to 1 mm long; upper surface plane, white-maculate, becoming heavily pycnidiate, isidia and soredia lacking; medulla deep salmon orange; lower surface black, densely rhizinate, the rhizines black, simple or sparsely squarrosely branched, 0.5–1.0 mm long. Apothecia sessile to subpedicillate, 2–4 mm in diameter; spores 8, 6–7 × 9–11 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylin and related "subaurulenta" terpenes, secalonic acid A, and unidentified pigments).

DISTRIBUTION.—Japan.

REMARKS.—This rare Japanese species is very close to *P. denegans,* a pustulate or sorediate-pustulate species in tropical Asia. Both have a more deeply pigmented medulla, especially in the lower half, than other members of section *Myelochroa.* I have not been able to resolve these pigments with the usual chromatographic solvent systems. *Parmelina amagiensis* appears to be somewhat more robust than *P. denegans,* judging from the few specimens available, and does not seem to be a parent morph for the latter.

SPECIMENS EXAMINED.—Japan: Prov. Ettchu, *Yanagisawa* 599a (TNS); Prov. Hyuga, *Kurokawa* 50058 (TNS, US).

2. *Parmelina antillensis*

FIGURE 11*b*

Parmelina antillensis (Nylander) Hale, 1974:482.

Parmelia antillensis Nylander, 1868:264 [type collection: Matouba, Guadeloupe, *Husnot* 445 (H. Nylander herbarium number 35119, lectotype; isolectotypes in G, P)].

Parmelia blastica Vainio, 1896:32 [type collection: Shawford Estate, Dominica, *Elliott* 899 (TUR, lectotype; isolectotype in BM)].

DESCRIPTION.—Thallus adnate on bark, fragile and membranous, up to 10 cm across, greenish mineral gray, often more or less white-pruinose at the lobe tips; lobes irregularly branched, subimbricate to convoluted, the marginal cilia sparse, mostly in lobe axils, to 0.5 mm long; upper surface shiny, plane, cortex continuous or cracked with age; densely isidiate, the isidia fine, to 0.4 mm high, sparingly branched or simple; lower surface black, brown and shiny in a narrow zone along the margins, densely rhizinate, the rhizines simple. Apothecia adnate, 3–5 mm in diameter, the amphithecium isidiate; spores 8, 5–6 × 7–8 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K+ yellow turning red, C−, KC−, P+ orange (norstictic and connorstictic acids).

DISTRIBUTION.—Caribbean region.

REMARKS.—*Parmelia antillensis* and its close Caribbean relative *P. phlyctina* are the only two species in the genus containing norstictic acid. This trait, along with the rather broad, apically rotund lobes, might tempt one to place them in *Parmotrema* Massalongo, where, in fact, I had originally suggested they might belong (Hale, 1959). The

lower surface, however, has at most a narrow bare or papillate zone, the lobes are generally adnate at the tips, not ascending, and the cilia are mostly in the axils of the lobes. Both *P. antillensis* and *P. phlyctina* share traits intermediate between *Parmelina* and *Parmotrema* and have evolved in a very restricted region, the rain forests of the Caribbean basin (excepting the unusual record of *P. antillensis* from the southeastern United States discussed in Hale, 1971b:46). Other parmelioid groups have evolved here, e.g., *Pseudoparmelia martinicana* (Nylander) Hale and *P. raunkiaeri* (Vainio) Hale and perhaps also *Relicina eximbricata* (Gyelnik) Hale (1975b, 1976a), but these are all lowland species in dry, disturbed habitats. Although *Parmelina antillensis* is often collected on citrus trees at 600–700 m elevation, its primary habitat is the canopy branches of trees in virgin rain forest.

Specimens Examined.—United States: Tennessee, *Yoshimura et al.* 660872 (US). Mexico: Chiapas, *Hale* 20238.[1] Cuba: Oriente, *Imshaug* 25051 (MSC). Jamaica: *Culberson* 13648, 13777, 13787 (DUKE), *Imshaug* 14088, 14627, 14943, 15321 (MSC), 14391, 15295 (MSC, US), *Orcutt* 3551b, 5626b (US), *Plitt* (US). Haiti: Ouest, *Imshaug* 22642 (MSC). Puerto Rico: *Stimson* 1440 (DUKE). Guadeloupe: *Culberson* 14511 (DUKE), *Ouestal* 1916 (US). Martinique: *Culberson* 14682 (DUKE), *Degelius* (Degelius herbarium). Dominica: *Imshaug* 32726 (MSC), *Hale* in *Lichenes Selecti Exsiccati* 942 (H, LD, US) (for additional records see Hale 1971a:10). St. Lucia: *Imshaug* 29712 (MSC). St. Vincent: *Imshaug* 30504 (MSC). Grenada: *Hale* 38298, *Imshaug* 16092, 16335 (MSC). Trinidad: *Hale* 38291, *Imshaug* 32042 (MSC). Barbados: *Elliott* (TUR). Venezuela: Mérida, *Hale* 42751, 42941. Brazil: Minas Gerais, *Vainio* in *Lichenes Brasilienses Exsiccati* 675 (TUR) (distributed as *Parmelia amazonica*).

3. *Parmelina aurulenta*

Figures 10, 11*c*

Parmelina aurulenta (Tuckerman) Hale, 1974:482.

Parmelia aurulenta Tuckerman, 1858:424 [type collection: Harpers Ferry, Virginia, *Tuckerman* (FH-Tuck, lectotype)].

Parmelia tiliacea var. *efflorescens* Müller Argoviensis, 1887:316 [type collection: Siberia, Russia, *Lahm* 5 and 6 (G, lectotype; isolectotype in W)].

Parmelia albido-straminea Hue, 1899:161 [type collection: Sanctum Dionysium, Réunion, *Rodriguez* (PC, lectotype)].

Parmelia subrevoluta Harmand, 1928:326 [type collection: Cha Pon, Indochina, *Demange* (PC, lectotype)].

Parmelia hunanensis Zahlbruckner, 1930:187 [type collection: Tschangscha, Hunan, China, *Handel-Mazzetti* 11454 (WU, lectotype)].

Parmelia silvestris Degelius, 1940:47 [type collection: Togue Pond near Mt. Katahdin, Maine, *Degelius* (Degelius herbarium [not seen]; isolectotype in US)].

Parmelia aurulenta var. *silvestris* (Degelius) Degelius, 1941:58.

Description.—Thallus adnate on bark or rock, pale greenish mineral gray, 4–10 cm broad; lobes sublinear to subirregular, apically subrotund, 2–4 mm wide, the marginal cilia irregularly dispersed but mostly in the lobe axils, to 0.8 mm long; upper surface shiny, plane to rugulose, soon sorediate to pustulate-sorediate, the soralia up to 1 mm in diameter, coalescing into large subcapitate clumps, the soredia coarse (Figure 5*a*); medulla white and becoming orange sulfur yellow only beneath soralia and near exposed cracks in the upper cortex or entirely sulfur yellow; lower surface black and moderately to densely rhizinate, the rhizines black, simple or becoming sparsely furcate or squarrosely branched. Apothecia rare, adnate to substipitate, the amphithecium sorediate-pustulate, 2–5 mm in diameter; spores poorly developed, 7 × 12 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla negative with color reagents or if pigmented areas tested becoming more intensely yellow (zeorin, leucotylic acid and related terpenes, and secalonic acid A).

Distribution.—Pantemperate and montane pantropical (Figure 10).

Remarks.—*Parmelina aurulenta* is one of the most widespread species in the genus and, at least in the United States, is one of the most commonly collected foliose lichens. It is also unusual in being the only species of the *subaurulenta* complex that occurs in the New World, perhaps suggesting merely that efficient dispersal by soredia is the prime reason for the pantemperate distribution.

Soredial formation is extremely variable. The lectotype, for example, is densely pustulate with well developed soredia that obscure most of the pustular initials (Figure 5*a*). At other times, the pustules become only sparsely and coarsely sorediate, this being especially true of saxicolous forms. In no case, however, do the pustules remain intact as in *P. leucotyliza*, a Japanese species. In Japan the two species may also be separated by chemistry since *P. leucotyliza* produces the "subaurulenta" terpenes. There is a very minor amount of variability in chromatograms of *P. aurulenta* from different

[1] Entries without herbarium designations of specimens collected by Hale are in US.

FIGURE 10.—Distribution of *Parmelina aurulenta* based on all available herbarium specimens.

geographic areas but it does not seem significant or consistent. I did not, incidentally, recheck the terpene profiles of *Parmelia tiliacea* var. *efflorescens*, *P. albido-straminea*, *P. subrevoluta*, or *P. hunanensis*, but assumed that they have the "aurulenta" terpenes since they are sorediate and fall outside the range of *P. leucotyliza*. Should any of them be found to contain "subaurulenta" terpenes, the nomenclature of *P. aurulenta* would not change.

The parent morph of *Parmelina aurulenta* might well be *P. irrugans*, which is identical in chemistry. It would be desirable, however, to examine more specimens of *P. irrugans* in relation to *P. aurulenta* in Japan before making a final decision.

The ecology of *P. aurulenta* has been intensively studied in Wisconsin, an area of typical deciduous and conifer forests well within its range. For example, I found in 1955 that it occurred on 30% of a 2800 tree sample at the 1.3 m level on the trunk and on 21% at base level in mesic deciduous forests. It was most common in closed oak-hickory stands and much rarer in both open, savanna-like oak stands and in heavily shaded maple (*Acer saccharum*) climax forests. *Parmelina aurulenta* occurs frequently with *Parmelia rudecta* Acharius and *Pseudoparmelia caperata* (L.) Hale.

In northern Wisconsin, an area of hardwood-conifer forests more comparable in climate to northern Europe, *P. aurulenta* had an overall frequency of only 11.6% at the 1.3 m level and 1.3% at the base. It avoided *Pinus* spp. and grew almost exclusively on *Acer* and *Quercus* (W. Culberson, 1955). This avoidance of *Pinus* was demonstrated even more graphically by W. Culberson (1958) in an ecological survey exclusively of *Pinus* in North Carolina. Although otherwise common in this state, not a single collection was made on conifers.

SPECIMENS EXAMINED.—United States and Canada: See Hale (1958:84) for a map of distribution based on specimens in various American herbaria. Mexico: Michoacán, *Wirth* 329 (US). Brazil: Minas Gerais, *Eiten* 6932 (US). Europe: Russia, *Vasiljeva* 9 (US). Tanzania: Tanga Province, *Santesson* 23358, 23359 (Santesson herbarium, US). Union of South Africa: Natal, *Almborn* 8071, 8079 (LD); Transvaal, *Almborn* 7225 (LD). Madagascar: *des Abbayes* (TUR), *Lemaitre* (H). Paki-

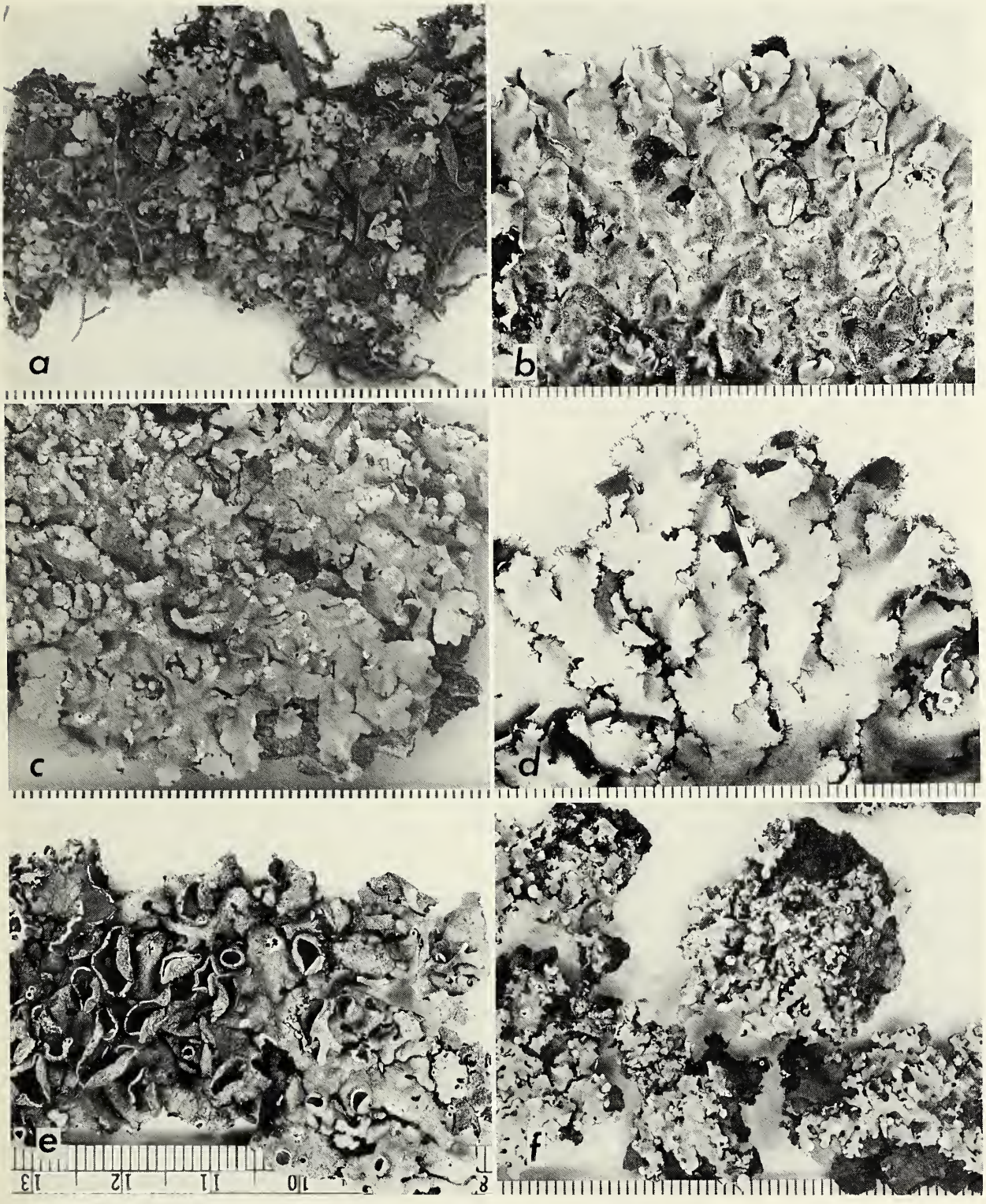

FIGURE 11.—Species of *Parmelina*: *a*, *P. amagiensis* (*Kurokawa* 550058 in US); *b*, *P. antillensis* (*Hale* 38291); *c*, *P. aurulenta* (*Hale* 18941); *d*, *P. consors* (*Reitz and Klein* 15973 in US); *e*, *P. crassata* (*Kurokawa* 550446 in US); *f*, *P. cryptochlora* (*Hale* 37782). (Scale in mm.)

stan: *Ahmad* 211 (L), *Iqbal* 831, 839, 843 (US). Nepal: *Norkett* 9368 (BM). India: Almora District, *Awasthi* 3970 (Awasthi herbarium, US); Kangra District, *Höeg* 1492, 1497 (Awasthi herbarium); Punjab: *Schelpe* 3260 (BM); Tamil Nadu: *Hale* 43664, 43812, 43816; Uttar Pradesh, *Awasthi* 3374 (Awasthi herbarium); West Bengal, *Togashi* (TNS). Sri Lanka: *Degelius* As–407 (Degelius herbarium), *Thwaites* 32 (BM). China: Kiangsi Province, *Tai* (BM). Taiwan: *Kurokawa* 1359, 1390, 2694 (TNS). Korea: *Den* (TNS). Hong Kong: without collector, 1897 (BM, US); *Hale* 46393. Japan: Prov. Aki, *Yanagisawa* 746–1 (TNS); Prov. Awa, *Inobe* 23 (TNS); Prov. Higo, *Mayebara* 169 (TNS) *Togashi* in *Lichenes Japoniae Exsiccati* 177 (US); Prov. Hizen, *Kurokawa* 62615 (TNS); Prov. Kii, *Kurokawa* 59129 (TNS, US), *Sasaki* 481 (TNS); Prov. Settsu, *Hale* 29417, 29428; Prov. Shimotsuke, *Kurokawa* 56509 (TNS). Philippines: Benguet, *Degelius* As–888 (Degelius herbarium). Indonesia: Java, *Groenhart* 5872 (L, US). New Guinea: Morobe District, *Weber and McVean* L–51280 (COLO, US). Hawaiian Islands: Maui, *Faurie* 514 (LD), 866 (BM, PC), *Hale* 31543; Kauai, *Hale* 31747, 31755.

4. *Parmelina consors*

FIGURE 11*d*

Parmelina consors (Nylander) Hale, 1974:482.

Parmelia consors Nylander, 1885:613 [type collection: Minas Gerais, Brazil, *Weddell* (H, Nylander herbarium number 35277, lectotype)].

Parmelia balansae Müller Argoviensis, 1888a:1 [type collection: Asunción, Paraguay, *Balansa* 8 (G, lectotype)].

Parmelia sampaiana Hue, 1899:170 [type collection: São Paulo, Brazil, *Sampaio* (PC, lectotype)].

Parmelia continentalis Lynge, 1914:111 [type collection: Corumba, Mato Grosso, Brazil, *Malme* 48 (S, lectotype)].

DESCRIPTION.—Thallus adnate on bark, coriaceous greenish mineral gray and turning deep olivebuff in the herbarium, 5–10 cm in diameter; lobes irregularly branched, sublinear-elongate to subirregular, apically rotund, often imbricate, 1–4 mm wide, the margins crenate, moderately to densely ciliate, the cilia stout, blackish brown to black, becoming furcate, 0.2–1.0 mm long; upper surface shiny, becoming heavily maculate, sometimes pruinose towards the tips, isidia and soredia lacking; medulla white; lower surface black, moderately rhizinate, the rhizines black, thick and thin intermixed, simple or squarrose. Apothecia substipitate, 2–8 mm in diameter, amphithecium smooth, the disc cinnamon brown, rarely perforate; spores 8, 8–12 × 14–19 μm.

CHEMISTRY.— Cortex K+ yellow (atranorin); medulla negative with color tests (no substances demonstrated).

DISTRIBUTION.—South America.

REMARKS.—This robust, coriaceous lichen is characterized by its heavily white-maculate cortex (Figure 3*a*), thick, furcate cilia (Figure 3*a*), and lack of medullary chemistry. It is also the only species assigned to *Parmelina* with perforate apothecia, a trait usually associated with *Parmotrema* Massalongo. The dense rhizine mat below to the margin and the generally close adnation, however, do not conform to *Parmotrema*. *Parmelina consors* is evidently a common lichen in dry, scrubby forests and on trees along roads. The presumptive sorediate morph, *P. pilosa*, has a broader distribution in South America and also occurs in Africa.

SPECIMENS EXAMINED.—Brazil: *Wawra* 669 (M); Mato Grosso, *Montes* 10146 (DUKE, LD, US); Minas Gerais, *Malme* 201B (S), *Vainio* in *Lichenes Brasilienses Exsiccati* 398 (BM, M, TUR); Rio de Janeiro, *Burchell* 2303 (BM), *Gardner* 37 (BM), *Glaziou* 1821, 1836 (M), 1840 (M, S), *Hemmendorff* 5386 (S, UPS), *Milne* (BM); Rio Grande do Sul, *Malme* 1282 (LD, S, UC, UPS, US); Santa Catarina, *Reitz and Klein* 12901, 15973, 16032a (US); São Paulo, *Eiten* 5731 (US), *Gehrt* (US), 5924 (MICH), *Puiggari* (G). Paraguay: Itapua, *Malme* 1462 (S, UPS, US). Uruguay: Lavellaja, *Lamb* (H). Argentina: Buenos Aires, *Kuhnemann* 22 (S), *Santesson* 76, 77a (S); Misiones, *Montes* 36 (US), 3353 (WIS).

5. *Parmelina crassata*, new species

FIGURE 11*e*

DESCRIPTION.—Thallus laxe adnatus, corticola, crassatus coriaceusque, cinereo-albidus vel obscurascens, usque ad 15 cm latus, lobis sublinearibus vel subirregularibus, contiguis vel congestis, 3–6 mm latis, margine ciliatis, ciliis irregulariter dispersis, nigris, 0.3–0.8 mm longis, superne planus vel aetate rugulosus, nitidus, continuus, isidiis sorediisque destitutus, cortex superior ca. 12 μm crassus, epicorticatus, stratum gonidale 16–18 μm crassum, medulla omnino sulphureo-salmonea, 160–210 μm crassa, cortex inferior fuscus, 14–16 μm crassus, subtus niger, dense rhizinosus, rhizinis nigris, nitidis, 1–2 mm longis, simplicibus vel pro parte furcatis vel squarroso-ramosis. Apothecia numerosa, subpedicillata, amphithecio rugoso, usque ad 10 mm diamentro, sporis octonis, 6–8 × 14–15 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylin and associated terpenes, and secalonic acid A).

HOLOTYPE.—Mt. Akagi, Japan, *S. Kurokawa* 550466, 23 August 1955 (US; isotype in TNS).

DISTRIBUTION.—Japan.

REMARKS.—This is another member of the *P. subaurulenta* group so abundantly developed in Japan. It has the same chemistry as *P. subaurulenta* but is well separated by the larger, leathery thallus, averaging 218 μm in thickness (sample of 10 specimens), as opposed to 150 μm for *P. subaurulenta*. It also has significantly larger, substipitate apothecia. *Parmelia irrugans*, which has large apothecia, can be distinguished by chemistry (the "aurulenta" terpenes) and thinner thallus.

This species previously had been identified (along with *P. irrugans*) as "Parmelia homogenes" in Japan, but, as explained below, *P. homogenes* was misinterpreted and is in reality the same as *P. subaurulenta*. *Parmelia crassata* is a common species in Japan, but since I have not had an opportunity to re-examine the chemistry of the rich collections in TNS, I have cited below only those specimens also represented in US.

SPECIMENS EXAMINED.—Japan: Prov. Kozuke, *Kurokawa* 58583 (TNS, US); Prov. Sagami, *Kurokawa* 58039 (TNS, US); Prov. Suruga, *Asahina* 539, 2627 (US).

6. *Parmelina cryptochlora*

FIGURE 11*f*

Parmelina cryptochlora (Vainio) Hale, 1974:482.

Parmelia cryptochlora Vainio, 1896:34 [type collection: Laudat, Dominica, *Elliott* 912 (BM, lectotype)].

DESCRIPTION.—Thallus closely adnate on bark, whitish mineral gray, 1–3 cm broad; lobes sublinear, separate to crowded, 1–2 mm wide, the marginal cilia sparsely developed, 0.1–0.3 mm long; upper surface plane to convex, sorediate toward the tips, the soralia capitate, up to 1 mm in diameter (Figure 5*b*), the sorediate lobe tips becoming revolute; lower surface black, sparsely rhizinate, the rhizines black, simple. Apothecia not seen.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K−, C+ rose, KC+ red, P− (gyrophoric acid).

DISTRIBUTION.—West Indies and India (?).

REMARKS.—As I explained in my study of the *Parmeliae* of Dominica (Hale, 1971a:12), Vainio's type collection is so poor that I had not been able to interpret it until I collected additional specimens from the type-locality in Dominica. It is rather common at one locality (base of Morne Anglais) on trees in a pasture at 600–800 m elevation. One collection that I made in South India also appears to be this species. It is so small and inconspicuous that it has undoubtedly been overlooked elsewhere or, if collected, has been set aside as unidentifiable. It has the same chemistry as *P. dissecta*, a common species with which it is clearly allied as the sorediate morph of the extinct or still undiscovered parent morph. It also has the same chemistry as sorediate *Hypotrachyna revoluta* (Floerke) Hale, which would normally be amply distinguished by a larger thallus, more ascending lobes, dichotomously branched rhizines, and broader sorediate pustules. A poorly developed specimen of *H. revoluta*, however, and a large specimen of *P. cryptochlora* would have to be separated with extreme care.

SPECIMENS EXAMINED.—Dominica: *Hale* 35357, 37782. India: Tamil Nadu, *Hale* 40203.

7. *Parmelina damaziana*, new combination

FIGURE 12*a*

Parmelia damaziana Zahlbruckner, 1905:541 [type collection: Mt. Ituculumi, Brazil, *Damazio* 1375 (W, lectotype; isolectotype in G)].

Parmelia brachyconidia Zahlbruckner, 1908:465 [type collection: Vellozo, Serra do Ouro Preto, Brazil, *Damazio* 1741 (W, lectotype)].

Parmelia brachyconidia var. *chlorocarpa* Zahlbruckner, 1908:466 [type collection: Cachoeira do Campo, Brazil, *Damazio* 1740 (W, lectotype)].

Parmelia crystallorum Lynge, 1914:128 [type collection: Corcovado, Rio de Janeiro, Brazil, *Malme* 59* (S, lectotype)].

DESCRIPTION.—Thallus closely adnate on twigs, whitish ashy mineral gray, 3–6 cm broad; lobes short, sublinear-elongate to subirregular, 1–3 mm wide, the marginal cilia evenly dispersed, about 0.5 mm long; upper surface plane, shiny; lower surface black, moderately rhizinate, the rhizines simple, black. Apothecia common, sessile to substipitate, to 12 mm in diameter, the disc flat, often radially split; spores 8, 8–12 × 12–18 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K−, C−, KC+ rose, P− ("horrescens" unknown).

DISTRIBUTION.—South America.

REMARKS.—Although clearly distinct because of

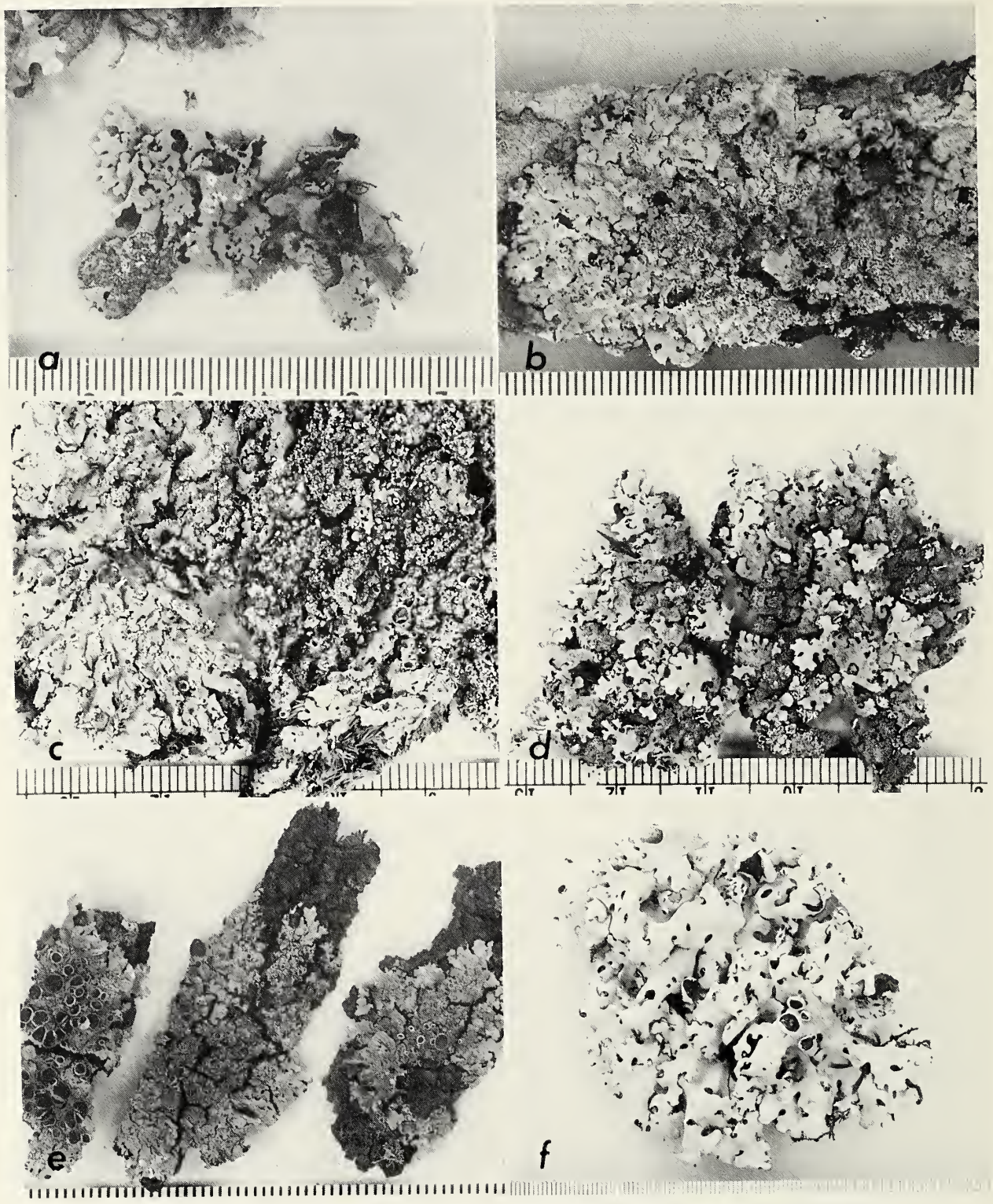

FIGURE 12.—Species of *Parmelina: a, P. damaziana* (*Damazio* 1375 in W); *b, P. degelii* (*Degelius* A–182 in Degelius herbarium); *c, P. denegans* (*Hale* 43855); *d, P. dissecta* (*Hale* 14999); *e, P. endoleuca* (*Weber* in *Lichenes Exsiccati* 244 in US); *f, P. enormis* (*Jellicoe* in US). (Scale in mm.)

the chemical constitutents, *P. damaziana* is a rare and not well comprehended species. The lectotype was collected on tree branches whereas Lynge's species was apparently saxicolous. *Burchell* 1105–06 is tentatively placed here since the chemistry, while not clear, is closest to the "horrescens" type. *Parmelina damaziana* has rather large spores, just as the other members of the *P. horrescens* group. It could be regarded theoretically as the parent morph for *P. horrescens, P. schindleria,* and *P. subfatiscens,* but all of these vegetative morphs have smaller, more fragile thalli.

Specimens Examined.—Brazil: *Burchell* 1105–06 (BM, US).

8. *Parmelina degelii,* new species

Figure 12*b*

Description.—Thallus adnatus, corticola, fragilis, pallide viridi-albicans, 6–8 cm latus, lobis plus minusve subirregularibus, 2–3 mm latis, margine aetate lobulato-dissectis, ciliatis, ciliis usque ad 0.8 mm longis, superne planus vel aetate rugulosus, nitidus, sparse vel modice isidiatus, isidiis primum cylindricis, mox procumbentibus, dorsiventralibus, expansis, ad 0.6 mm longis, cortex superior 12 μm crassus, epicorticatus, stratum gonidiale 12–14 μm crassum, medulla pallide sulfurea, 60–90 μm crassa, cortex inferior paraplectenchymatus, brunneus, 12 μm crassus, subtus niger, dense rhizinosus, rhizinis nigris, simplicibus, 0.5–09 mm longis. Apothecia ignota.

Chemistry.—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylic acid, apparently secalonic acid A, and traces of other pigments and terpenes).

Holotype.—Rain forest, Cairns Cove, Queensland, Australia, elevation 600 m, *G. Degelius* A–182 (Degelius herbarium; isotype in US).

Distribution.—Australia.

Remarks.—This is the only species of section *Myelochroa* that has been discovered in Australia. It is remarkable that such a conspicuous lichen should be collected so recently in Queensland. The terpene chemistry is close to *P. aurulenta* except for the absence of one spot (Figure 7). Regardless of chemistry, however, it is distinct from all other species in the *P. subaurulenta* complex because of the production of large lobulate isidia. *Parmelina degelii* is named in honor of Dr. Gunnar Degelius, who has enriched our knowledge of lichen distributions through his careful collecting efforts in the tropics.

9. *Parmelina denegans*

Figure 12*c*

Parmelina denegans (Nylander) Hale, 1974:482.

Parmelia denegans Nylander, 1900:6 [type collection: Rampodde, Ceylon, *Almquist* (H, Nylander herbarium number 35129, lectotype; isolectotype in S)].

Description.—Thallus adnate to closely adnate on bark, light greenish mineral gray, 5–9 cm broad; lobes irregularly branched, sublinear, imbricate, 1–3 mm wide, the marginal cilia irregularly dispersed, 0.4–0.7 mm long; upper surface shiny, weakly maculate, plane but soon developing small pustulate areas, the pustules eventually breaking open apically and forming coarse soredia; medulla pale orange-salmon, in part K+ purple; lower surface black, densely rhizinate, the rhizines black, simple to sparsely branched. Apothecia sessile, 2–3 mm in diameter; spores 8, 5–7 × 7–9 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla more intensively yellow-orange with color tests (zeorin, leucotylin and associated terpenes, secalonic acid A, and possibly anthraquinones).

Distribution.—India, Sri Lanka, and Sabah.

Remarks.—Except for the darker reddish orange pigment in the lower part of the medulla, this species is the pustulate morph of *P. subaurulenta.* They have similar lobe configuration and habitats, occurring at about 2000 m elevation in open forests. The lectotype specimen is fertile and has few pustules. The specimens that I collected are heavily pustulate-sorediate by contrast.

Specimens Examined.—India: Tamil Nadu, *Foreau* 4128 (Awasthi herbarium, US), *Hale* 40239, 43636, 43762, 43855. Sri Lanka: *Thwaites* (UPS). Sabah: *Hale* 29020.

10. *Parmelina dissecta*

Figures 12*d*, 13

Parmelina dissecta (Nylander) Hale, 1974:482.

Parmelia dissecta Nylander, 1882:451 [type collection: Fontainebleau, France, *Nylander* (H, Nylander herbarium number 35131, lectotype; isolectotype in PC)].

Parmelia laevigata var. *gracilis* f. *furfuracea* Müller Argovien-

sis, 1888c:529 [type collection: Faxina, Brazil, *Puiggari* 47 (G, lectotype)].
Parmelia minarum Vainio, 1890:48.
Parmelia amazonica var. *husnotii* Hue, 1899:158.
Parmelia puiggari Gyelnik, 1931:288 [based on *Parmelia laevigata* var. *gracilis* f. *furfuracea* Müller Argoviensis].
Parmelia camtschadalis var. *epiphylla* Cengia Sambo, 1938:379.
Parmelia hubrichtii Berry, 1941:102.

[For full citation of synonymy, see Hale, 1971a:6.]

Description.—Thallus adnate on bark or rock, yellowish glaucous to pale greenish mineral gray, 3–7 cm broad; lobes sublinear-elongate, contiguous, 1–3 mm wide, the marginal cilia irregularly dispersed, mostly simple, to 0.7 mm long; upper surface shiny, emaculate, plane to convex, moderately to densely isidiate, the isidia cylindrical, erect, often branched, less than 0.5 mm high; medulla white; lower surface black, moderately rhizinate, the rhizines black, shiny, simple or sparsely branched. Apothecia adnate, the rim crenate, the amphithecium isidiate; 1–4 mm in diameter; spores 8, 8–10 × 12–17 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K−, C+ rose, KC+ red, P− gyrophoric acid with or without associated unknown substances).

Distribution.—Pantemperate and montane pantropical (Figure 13).

Remarks.—This is one of the most widespread and commonly collected species in the genus, especially in temperate zones, occurring on a wide variety of substrates in open, secondary forests. In tropical regions it is strictly montane, usually being most abundant in cloud forests up to 2300 m elevation. Morphological variation is wide, even though the basic characters, isidia, ciliate lobes, and gyrophoric acid, are constant. The lobes, for example, are narrow, sublinear, and separate in the lectotype specimen. At the other extreme are plants such as those collected in Dominica (Hale, 1971a) with broader, contiguous to subimbricate lobes.

Figure 13.—Distribution of *Parmelina dissecta* based on all available herbarium specimens.

Parmelina dissecta has been correctly identified by European lichenologists both on the Continent and in tropical regions. Degelius (1941:60) was the first to identify the species correctly in North America. He noted two populations differing in C test (C+ rose or C−) and presence or absence of cilia on the isidia. Hale and Kurokawa (1962) determined that the C− ciliate population is *P. horrescens*. No parent morph has been discovered for *P. dissecta*, but it forms a convenient nucleus of the "dissecta" group, including isidiate but significantly larger *P. melanochaeta*, sorediate *P. cryptochlora*, and isidiate-lobulate *P. subfatiscens* (Figure 9).

Specimens Examined (selected).—United States: Pennsylvania, *Hale* 17140; Maryland, *Hale* 14367; West Virginia, *Hale* 11470; Ohio, *Hale* 13910, 15735; Kentucky, *Hale* 13770; Virginia. *Hale* 38419, *Luttrell* 3799 (US); Tennessee, *Hale* 31124, 37038; North Carolina, *Culberson* 7099 (DUKE), *Hale* 30645; South Carolina, *Culberson* 7459 (DUKE), *Hale* 16601; Alabama, *Hale* 33937, *Skorepa* 4547 (US); Georgia, *Culberson* 7249 (DUKE), *Hale* 7509; Florida, *Nelson* (US) (see Moore, 1968:220 for additional records in Florida); Mississippi, *Hale* 7977, *Hubricht* 1532 (US); Texas, *Hale* 5242. Mexico: Chiapas, *Hale* 20304; Vera Cruz, *Hale* 21231. Panama: Chiriquí, *Hale* 38879. Cuba: Oriente, *Imshaug* 24720 (MSC). Jamaica: *Imshaug* 14172 (MSC). Guadeloupe: *Duss* 1030 (TUR). Dominica: *Hale* 35569 (see Hale, 1971a:13, for additional records). Martinique: *Degelius* (Degelius herbarium). St. Vincent: *Guilding* 46 (BM). Trinidad: *Imshaug* 32103 (MSC). Colombia: Antioquia, *Nee and Mori* 4258 (US). Venezuela: Distrito Federal, *Dennis* 1568 (BM); Mérida, *Hale* 42543; Táchira, *Hale* 42540, 45112. Brazil: Minas Gerais, *Eiten* 6867 (US); Paraná, *Montes* 10121 (MVM). Europe: Portugal, *Persson* (UPS), Sampaio in *Lichenes de Portugal* 252 (LD, US), *Tavares* 97 (H, LD, WIS), 632 (US); Spain, *Degelius* (S), *Santesson* 19428 (UPS), *Schauer* in *Lichenes Selecti Exsiccati* 265 (LD, US); France, *des Abbayes* in *Lichenes Armoricani Spectabiles Exsiccati* 88 (LD, W), *Hasselrot* (S); Italy, *Gresino* (S), *Sbarbaro* (US). Kenya: Rift Valley Province, *Maas Geesteranus* 6067 (L). Tanzania: Tanga Prov., *Santesson* 23137 (UPS). Union of South Africa, Cape Province, *Almborn* 301, 670, 3201 (LD); Natal, *Almborn* 9192, 9525 (LD), *Höeg* (TRH). Swaziland: *Almborn* 7904 (LD). India: Tamil Nadu, *Degelius* As–238 (Degelius herbarium), *Hale* 40222, 43715, 43852; West Bengal, *Degelius* As–211 (Degelius herbarium). Sri Lanka: *Degelius* As–466 (Degelius herbarium, US). Malay: Pahang, *Hale* 30137, 30483. Taiwan: *Kurokawa* 2400 (TNS). Japan: Prov. Aki, *Hale* 29368; Prov. Higo, *Mayebara* 158 (TNS); Prov. Kazusa, *Kurokawa* 64096 (TNS); Prov. Ohmi, *Hale* 29484; Prov. Owari, *Asahina* 146 (TNS); Prov. Settsu, *Hale* 29411. Philippines: Mountain Province, *Degelius* As–785 (Degelius herbarium), *Hale* 26040. Indonesia: Java, *Groenhart* 6022 (L), 8483 (BOR); Sumatra, *Groenhart* 967 (L). Hawaii: *Hale* 31340, 32933.

11. *Parmelina endoleuca*, new combination

Figure 12*e*

Parmelia endoleuca Taylor, 1847:167 [type collection: Swan River, Australia, *Drummond* (FH-Tayl, lectotype)].

Description.—Thallus closely adnate on bark, whitish mineral gray, 2–4 cm broad; lobes sublinear to subirregular, short and crowded, 1–2 mm wide, the marginal cilia sparse, less than 0.3 mm long; upper surface shiny, plane to minutely rugulose, becoming more strongly rugose and lobulate toward the center, heavily pycnidiate, soredia and isidia lacking; medulla white; lower surface dark brown at the margins and black toward the center, moderately rhizinate, the rhizines simple, brown but blackening at maturity. Apothecia very numerous, sessile, 1–2.5 mm in diameter, the disc dark brown, plane; spores 8, 6–7 × 11–12 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla negative with color tests (an unidentified fatty acid).

Distribution.—Australia.

Remarks.—In my earlier work on *Parmelia* I placed this species in synomymy under *Parmelina galbina*, a Japanese–North American species. Since the Australian locality seemed at variance with the Arcto-Tertiary distribution pattern of *P. galbina* and since my first chemical tests had been done with crystal techniques, I have checked the type of *Parmelia endoleuca* again and found that it contains neither galbinic acid nor any of the associated terpenes that characterize *P. galbina*. I have concluded, therefore, that *Parmelia endoleuca* is a good species in spite of the very close external resemblance to *P. galbina*. The fatty acid falls higher on the chromatographic plates than either caperatic acid or protolichesterinic acid. The species is endemic to the dry scrub forests of eastern Australia.

Specimens Examined.—Australia: Australian Capital Territory, *Weber* in *Lichenes Exsiccati* 244 (COLO, US).

12. *Parmelina enormis*

Figure 12*f*

Parmelina enormis (Hale) Hale, 1974:482.

Parmelia enormis Hale, 1972c:344 [type collection: Nyaka Plateau, Zambia, *Jellicoe*, September 1968 (BM, holotype; isotype in US)].

Description.—Thallus expanded, loosely attached on rock, coriaceous, whitish to ivory mineral gray, 10–30 cm broad; lobes sublinear, dichotomously branched, imbricate and crowded toward the center, 5–8 mm wide, the margins entire, ciliate mostly in the lobe axils, the cilia to 2.0 mm long; upper surface plane to convex, continuous, lacking soredia and isidia; medulla white; lower surface pale brown, densely rhizinate, the rhizines pale brown, simple. Apothecia numerous, subpedicillate, 3–8 mm in diameter; spores 8, 6–7 × 8–11 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K+ yellow turning red, C−, KC−, P+ orange (salazinic acid).

Distribution.—Zambia.

Remarks.—This species does not fit well in *Parmelina* if judged from lobe configuration alone. It appears to be a very large, typically sublinear *Hypotrachyna*, but the rhizines are simple (not dichotomously branched), the lower surface brown (not black), and the marginal cilia are distinct. No vegetative morphs are known. The species is known only from the type collection but should be found on rock outcrops in countries adjacent to Zambia.

13. *Parmelina entotheiochroa*

Figure 14*a*

Parmelina entotheiochroa (Hue) Hale, 1974:482.

Parmelia entotheiochroa Hue, 1899:161 [type collection: Hakodate, Japan, *Faurie* 104 pro parte (PC, lectotype; isolectotype in BM)].

Description.—Thallus adnate to loosely attached, fragile and easily breaking apart, saxicolous and corticolous, light greenish mineral gray with small sulfur-yellow patches where the cortex has broken away, 8–10 cm broad; lobes subirregular, congested, 2–3 mm wide, marginal cilia produced mostly in the lobe axils, about 0.5 mm long; upper surface plane and shiny on young lobes but soon becoming strongly rugose-wrinkled to pustulate, the surface dull and in part white pruinose, the wrinkles or pustules breaking open and large areas of cortex (1–3 mm across) breaking away to expose the deep sulfur-colored medulla; lower surface black except for a narrow brown zone at the tips, densely rhizinate to the margins, the rhizines black and shiny, simple or sparsely furcate. Apothecia rare, sessile, the amphithecium rugose, 2–4 mm in diameter; spores 8, 5 × 10–11 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylin and associated terpenes, and secalonic acid A).

Distribution.—Korea and Japan.

Remarks.—This is one of the commonest lichens in Japan, recognizable by the large rather fragile thallus with patches of the yellow medulla visible where the cortex breaks away (Figure 6*a*). It grows on both trees and rocks in open forests. The densely pustulate-rugose areas are more or less identical to those of *P. rhytidodes* but they differ in breaking open. In addition, *P. rhytidodes* has a different terpene profile, the "aurulenta" series. *Parmelina entotheiochroa* is clearly a member of the *P. subaurulenta* group, most closely related to *P. leucotyliza* and lacking a parent morph.

Specimens Examined.—Korea: *Fujikawa* (TNS). Japan: Prov. Aki, *Hale* 29534; Prov. Awa, *Kishida* (TNS); Prov. Bitchu, *Yoshino* (TNS); Prov. Etchu, *Asahina* (TNS); Prov. Higo, *Fujikawa* (TNS); Prov. Ise, *Uemara* 102 (US); Prov. Izu, *Asahina* (TNS); Prov. Kii, *Kurokawa* 64131 (TNS), *Numajiri* 394 (TNS); Prov. Kozuke, *Uematsu* 388 (TNS); Prov. Musashi, *Kurokawa* 550535 (TNS, US), *Nakaji* 50 (TNS); Prov. Ohmi, *Hale* 29456a; Prov. Rikuzen, *Iishiba* 43 (US); Prov. Satsuma, *Fujikawa* (TNS); Prov. Settsu, *Ui* 2667 (TNS); Prov. Shimotsuke, *Asahina* (TNS), *Culberson* 10680 (DUKE, US); Prov. Shinano, *Kurokawa* 51620 (TNS, US), *Togashi* 5100 (TNS); Prov. Suruga, *Asahina* (TNS).

14. *Parmelina expallida*

Figure 14*b*

Parmelina expallida (Kurokawa) Hale, 1974:482.

Parmelia expallida Kurokawa, 1968a:191 [type collection: Mt. Nanfong, Prov. Kaoshiung, Taiwan, *Kurokawa* 2930 (TNS, holotype)].

Description.—Thallus adnate on bark, whitish mineral gray, 5–7 cm broad; lobes sublinear, more or less imbricate, 1–3 mm wide, the marginal cilia sparse, simple, about 0.5 mm long; upper surface plane, emaculate and opaque, densely isidiate, the isidia cylindrical, simple or becoming coralloid-branched, 0.3–1.0 mm high; medulla white; lower surface pale brown or darkening, moderately rhizinate, the rhizines simple or rarely furcate, about 0.5 mm long. Apothecia rare, sessile, the rim crenate and the amphithecium isidiate, 2–5 mm in diameter; spores 8, 8–10 × 14–17 μm.

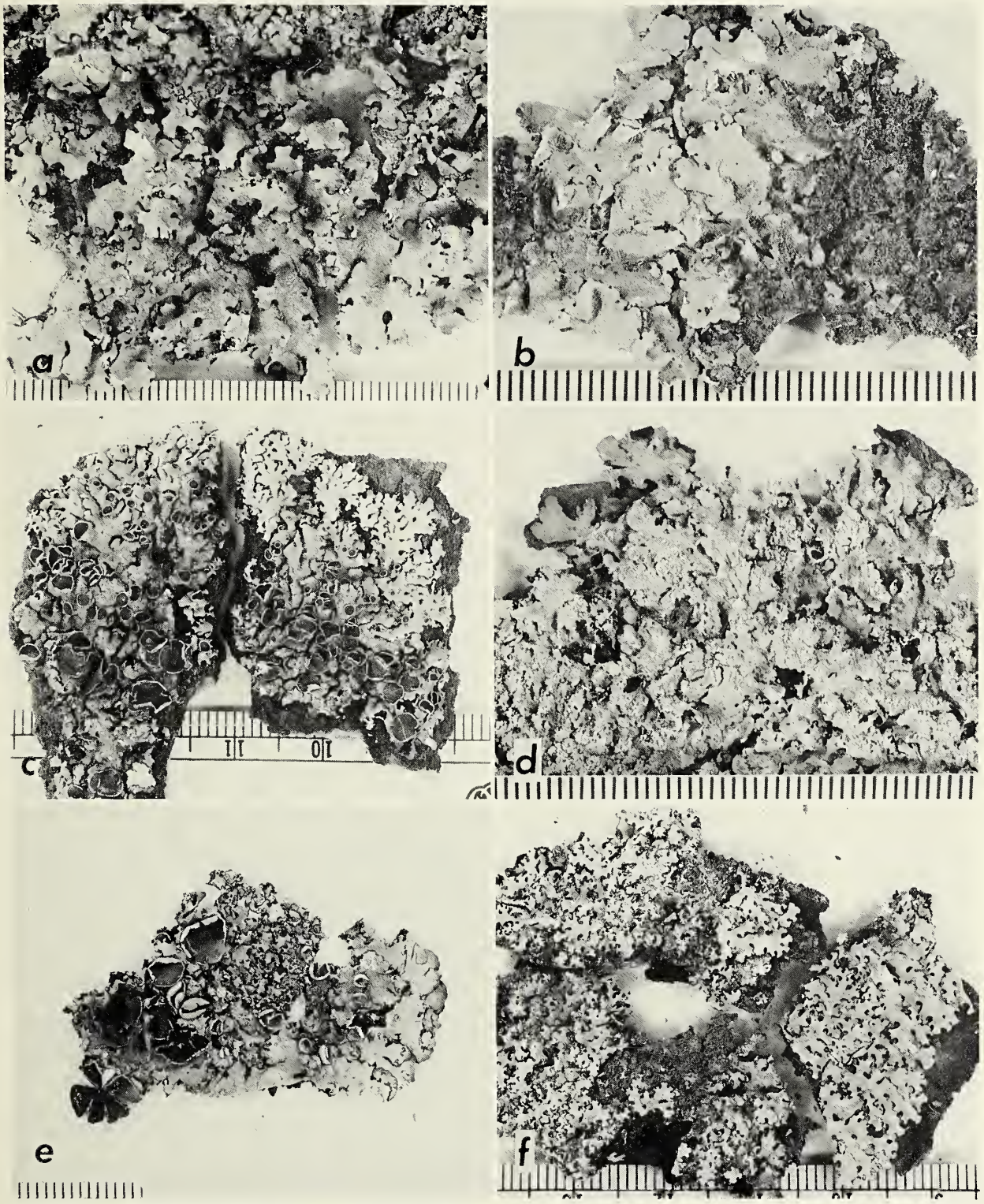

FIGURE 14.—Species of *Parmelina*: *a*, *P. entotheiochroa* (*Hale* 29456a); *b*, *P. expallida* (Kurokawa 2930 in TNS); *c*, *P. galbina* (*Hale* 23415), *d*, *P. hayachinensis* (*Kurokawa* 67081 in TNS); *e*, *P. heteroloba* (*Schiffner* in W); *f*, *P. horrescens* (*Hale* 36959).

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla negative with color tests (protolichesterinic acid and an unidentified fatty acid).

DISTRIBUTION.—India, Thailand, and Taiwan.

As pointed out by Kurokawa (1968a:191), an unusual feature of this species is the brown lower surface, indicating some relationship with *P. versiformis*, a South American species. It is also one of the few *Parmelinae* to produce a fatty acid.

SPECIMENS EXAMINED.—See Kurokawa (1968a:193) for records from India, Taiwan, and Japan.

15. *Parmelina galbina*

FIGURES 14*c*, 15

Parmelina galbina (Acharius) Hale, 1974:482.

Parmelia galbina Acharius, 1814:195 [type collection: North America (?Pennsylvania), *Muhlenberg* (H-Ach, lectotype; isolectotype in PH)].

Parmelia tiliacea var. *minor* Müller Argoviensis, 1877:78 [type collection: near Dallas, Texas, *Boll* (G, lectotype; isolectotypes in FH, M, W)].

Parmelia tiliacea var. *sulphurosa* Tuckerman, 1882:57 [type collection: Illinois, *Hall* (FH-Tuck, lectotype)].

Parmelia deminuta Hue, 1899:156 [type collection: Texas, *Boll* (PC, lectotype)].

Parmelia subquercifolia Hue, 1899:157 [type collection: Ohio, *Sullivant* (PC, lectotype)].

Parmelia subquercifolia var. *rugosa* Hue, 1899:175 [type collection: Oyama, Japan, *Faurie* (not seen)].

Parmelia tiliacea subquercifolia (Hue) Merrill and Burnham in Burnham, 1922:75 [rank not designated].

Parmelia quercina var. *sulphurosa* (Tuckerman) Zahlbruckner, 1929:192.

Parmelia sulphurosa (Tuckerman) Fink, 1935:328.

Parmelia laevigata ssp. *extremi-orientalis* f. *rugosa* (Hue) Asahina, 1951c:291.

Parmelia subquercifolia f. *subradiata* Asahina, 1952:98 [type collection: base of Mt. Fuji, Japan, *Yamamoto* (TNS, lectotype) (nomen nudum in Asahina, 1951c:291)].

Parmelia galbina var. *rugosa* (Hue) Asahina, 1963:225.

Parmelia galbina var. *subradiata* (Asahina) Asahina, 1963:225.

DESCRIPTION.—Thallus closely adnate on bark, yellowish-glaucous to greenish mineral gray, 3–10 cm in diameter; lobes short, sublinear, contiguous, 1–2 mm wide, marginal cilia mostly in axils, sometimes only sparsely developed, less than 0.5 mm long; upper surface plane to rugulose, continuous, pycnidia usually numerous; medulla white or pale yellow to orange, especially beneath the apothecia; lower surface densely rhizinate. the rhizines black, simple. Apothecia very common, adnate, 2–5 mm in diameter, the disc cinnamon brown; spores 8, 7–9 × 10–13 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K+ yellow, C− or C+ yellow, KC−, P+ pale orange (galbinic acid, zeorin, secalonic acid A, trace of salazinic acid, and leucotylin and associated terpenes).

DISTRIBUTION.—Japan and eastern North America.

REMARKS.—During a visit to the Academy of Natural Sciences in Philadelphia in 1958 I found a specimen in the Muhlenberg herbarium without a name but with a penciled number "15.2." I later found the same plant in the Acharian collection (H) also numbered 15.2 and described by Acharius as *Parmelia galbina*. This discovery clarified the status of one of the very common corticolous lichens in eastern North America. W. Culberson (1961:173) subsequently studied the problem and lectotypified *P. subquercifolia* Hue as synonymous with *P. galbina*. The second syntype of Hue's species was determined by Culberson to be *Parmelia livida* (= *Hypotrachyna livida* (Taylor) Hale), another very common corticolous lichen in eastern North America distinguished by more or less distinctly dichotomously branched rhizines and the lividic acid complex (Hale, 1975a:45). As a rule, *H. livida* has a whiter cast than *P. galbina*, is more robust, and lacks pigments in the medulla or under the apothecia. Still, care must be taken when identifying these two species. One other distinguishing character is the unique moniliform cells in the medulla of *P. galbina* and its morphs, *P. hayachinensis*, *P. metarevoluta*, and *P. obsessa*, first described by Asahina (1951c). The cells, however, are not easy to find and their exact significance is unknown at this time.

SPECIMENS EXAMINED.—United States: See W. Culberson (1961:171) for a discussion of the distribution and map of localities in North America based on specimens in DUKE and US (Figure 15). Japan: Prov. Aki, *Kurokawa* 64431 (TNS); Prov. Bungo, *Kurokawa* 63191 (TNS); Prov. Hizen, *Kurokawa* 62588 (TNS); Prov. Hoki, *Yasuda* (TNS); Prov. Hyogo, *Tagawa* L15 (TNS); Prov. Kozuke, *Degelius* As–1072 (Degelius herbarium); Prov. Mikawa, *Takaki* 353 (TNS): Prov. Musashi, *Kurokawa* 64279 (TNS); Prov. Mutsu, *Kurokawa* 550385 (TNS); Prov. Shimotsuke, *Kurokawa* 64057 (TNS); Prov. Shinano, *Kurokawa* 51758 (TNS, US), 59179 (TNS); Prov. Totomi, *Nakanishi* 27 (Kobe University); Prov. Ugo, *Suzuki* 272 (TNS).

FIGURE 15.—Distribution of *Parmelina galbina* in North America (taken from W. Culberson, 1961).

16. *Parmelina hayachinensis*

FIGURE 14*d*

Parmelina hayachinensis (Kurokawa) Hale, 1974:482.
Parmelia hayachinensis Kurokawa, 1968b:350 [type collection: Mt. Hayachine, Prov. Rikuchu, Japan, *Kurokawa* 67081 (TNS, holotype)].

DESCRIPTION.—Thallus adnate on bark, whitish to greenish mineral gray, 5–8 cm broad; lobes sublinear, 1.5–3 mm wide, marginal cilia simple, about 0.2 mm long; upper surface shiny, faintly maculate, becoming densely pustulate, the pustules becoming aggregated, erupting but not forming soredia; medulla white; lower surface black, densely rhizinate, the rhizines black, simple. Apothecia not seen.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K+ yellow turning red, C−, KC−, P+ orange (galbinic acid, leucotylin, and zeorin).

DISTRIBUTION.—Japan.

REMARKS.—As pointed out by Kurokawa (1968b: 350), this species is a member of the *P. galbina* complex, representing the pustulate morph. It is known only from the type collection growing on *Cryptomeria* in Japan.

17. *Parmelina heteroloba*

FIGURE 14*e*

Parmelina heteroloba (Zahlbruckner) Hale, 1974:482.
Parmelia heteroloba Zahlbruckner, 1909:171 [type collection: Mt. Itatiaya, Rio de Janeiro, Brazil, *Schiffner* (W, lectotype)].

DESCRIPTION.—Thallus adnate on bark, light buff mineral gray in the herbarium, 5–8 cm broad; lobes more or less sublinear, short and imbricate, becoming lobulate toward the center, 2–3 mm wide, the marginal cilia mostly in the lobe axils, to 0.4 mm long; upper surface shiny, plane to rugulose, becoming somewhat lobulate; lower surface black except for a narrow brown zone at the tips, densely rhizinate, the rhizines black, simple or sparsely furcate. Apothecia numerous, substipitate, the disc splitting, 2–9 mm in diameter; spores 8, 8 × 12 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla negative with color tests (an unidentified fatty acid and a faint unknown spot, perhaps related to one of the "horrescens" unknown).

DISTRIBUTION.—Brazil.

REMARKS.—Since this species is represented only by the single type collection, it is difficult to generalize on its affinities to other *Parmelinae*. It would probably be mistaken for *P. damaziana*, which has a different chemistry ("horrescens" unknown) and smaller spores. It is only one of three species in *Parmelina* with fatty acids, the others being *P. endoleuca* and *P. expallida*. *Parmelina heteroloba* has not been recollected at Mt. Itatiaya, a well known site that has been visited by several experienced lichen collectors, and it may be an extinct species.

18. *Parmelina horrescens*

FIGURE 14*f*

Parmelina horrescens (Taylor) Hale, 1974:482.
Parmelia horrescens Taylor in Mackay, 1836:144 [type collection: Dunkerron Mountains, Kerry, Ireland, *Taylor* (FH-Tayl, lectotype)].

DESCRIPTION.—Thallus closely adnate to adnate on bark, rocks, or mosses over rocks, whitish to greenish mineral gray, 2–5 cm broad; lobes more or less dichotomously branched, sublinear, often crowded and imbricate, 0.5–2.0 mm wide, the margins cre-

nate, often becoming lobulate, ciliate, the cilia more or less evenly dispersed, black, simple, 0.3–0.8 mm long; upper surface shiny, emaculate, densely isidiate, the isidia cylindrical, often branched and apically spinulate or short-ciliate, in part becoming procumbent; medulla white; lower surface black, moderately rhizinate, the rhizines black, simple. Apothecia rare, sessile, 2–4 mm in diameter, the amphithecium isidiate, the disc splitting at maturity; spores 8, 10–12 × 16–18 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K−, C− or C+ faint rose, KC+ rose or red, P− (trace of gyrophoric acid, "horrescens" unknown falling above gyrophoric acid on chromatographic plates, and one or two other unidentified spots).

Distribution.—Pantemperate and montane pantropical.

Remarks.—As discussed under *P. dissecta*, this species only recently was differentiated correctly from *P. dissecta* (Hale and Kurokawa, 1962:2), an isidiate lichen with gyrophoric acid. *Parmelina horrescens* is characterized by dense fine isidia with greater or lesser development of short apical cilia (Figure 4*c*). The isidia sometimes become procumbent and lobulate. On the whole, the lobes are somewhat narrower and more appressed than in *P. dissecta*. *Parmelina horrescens* has essentially the same geographic range as *P. dissecta* and occurs most abundantly in the temperate deciduous forests of the eastern United States and Japan. It is montane in the tropics, occurring as high as 3000 m in the paramos of Venezuela.

The chemistry of *P. horrescens* is now being studied by several lichen chemists. A number of unidentified spots appear in both hexane and benzene solvent systems, one of which is probably a trace of gyrophoric acid. The other spots fall above and below gyrophoric acid and seem to represent closely related depsides.

The parent morph of *P. horrescens* is probably extinct. Chemically identical *P. damaziana*, a non-isidiate Brazilian species, is larger and more robust although obviously from the same stock as the parent of *P. horrescens*. Among the parallel morphs, both pustulate-sorediate *P. subfatiscens* and lobulate *P. schindleri* are very close in lobe configuration, adnation, and thallus texture.

Specimens Examined.—United States: Illinois, *Skorepa* 4627 (US); Kentucky, *Hale* 13743a; West Virginia, *Hale* 10612, 11772, 11878; Virginia, *Hale* 18388, 33153, *Reed* 9091 (Reed herbarium), *Roller* 400 (US); North Carolina, *Culberson* 5114, 5706, 5744, 7134 (DUKE), *Hale* 18042, 15058, *Imshaug* 22174, 22178, 22353 (MSC, US); Tennessee, *Hale* 31106, 36921, 36959, 36970, *Moore* 284 (US), *Phillips* 358, 377 (US), *Skorepa* 5527 (US); South Carolina, *Hale* 7723; Georgia, *Hale* 7405, 7537, 16761, 16776, 30882, 30885; Alabama, *Hale* 7186, 7216, 31164, 33779, 33918, 34121, 34174, *McCullough* 2195 (US); Florida, *Hale* 21685 (for additional records see Moore, 1968:220). Mexico: Chiapas, *Hale* 20204, 20223, 20400a, 20414, 20549, 21086. Guatemala: Baja Vera Paz, *Hale* 45828. Panama: Darien, *Mori and Gentry* 4309 (US); Panamá, *Hale* 38451. Cuba: Oriente, *Imshaug* 24737, 24810, 24932 (MSC). Jamaica: *Imshaug* 14216 (MSC). Dominican Republic: Cordillera Central, *Imshaug* 23516 (MSC), *Wetmore* 3739 (MSC); La Vega, *Allard* 17695a (US). Haiti: Ouest, *Fabius* 2–4 (US), *Imshaug* 22768, 22837, 22860 (MSC, US), *Wetmore* 3222 (MSC); Sud, *Imshaug* 23233 (MSC, US). Venezuela: Distrito Federal, *Dennis* 2394 (BM), *Santesson* 6679 (S); Mérida, *Hale* 42038, 42067, 42952, 45121, 45201. Uruguay: Trienta y Tres, *Osorio* 5931 (MVM). France: *Harmand* (DUKE). Spain: Pontevedra, *Schauer* (M); Tenerife, *Imshaug* 34476, 35677 (MSC). Union of South Africa: Cape Province, *Almborn* 1442 (LD). India: Tamil Nadu, *Hale* 43784. Philippines: Mountain Province, *Hale* 26531. Indonesia: Java, *Groenhart* 2903 (L, US), 6279 (L), *Kurokawa* 2071 (TNS). Taiwan: *Kurokawa* 693 (TNS). Japan: Prov. Buzen, *Kurokawa* 62468, 63166 (TNS); Prov. Kii, *Kurokawa* 64127 (TNS); Prov. Ohmi, *Hale* 29465. Australia: New South Wales, *Cheel* L1708 (NSW), *Craigie* (NSW). New Zealand: *Wade* 85 (BM, US).

19. *Parmelina immiscens*

Figure 16*a*

Parmelina immiscens (Nylander) Hale, 1974:482.

Parmelia immiscens Nylander, 1885:606 [type collection: Orizaba, Mexico, *Galeotti* 6879 (PC, lectotype; isolectotype in H, Nylander herbarium number 35674)].

Parmelia michoacanensis Bouly de Lesdain, 1914:7 [type collection: Jesús del Monte, Morelia, Michoacán, Mexico, *Arsène* 4456 (US, lectotype; isolectotypes in COLO, DUKE, G, LE, and UPS)].

Description.—Thallus adnate on bark, pale turtle green, 5–10 cm in diameter; lobes subirregular and apically rotund, 2–6 mm wide, the marginal cilia mostly in the axils; upper surface plane, continuous, often pruinose near the tips; medulla sulphur yellow; lower surface densely rhizinate, short rhizinate and pale brown along the margins, the rhizines simple or squarrosely branched. Apothecia numerous, adnate, the disc pale, 2–7 mm in diameter; spores 8, 4–6 × 7–12 μm.

Chemistry.—Cortex K+ yellow (atranorin);

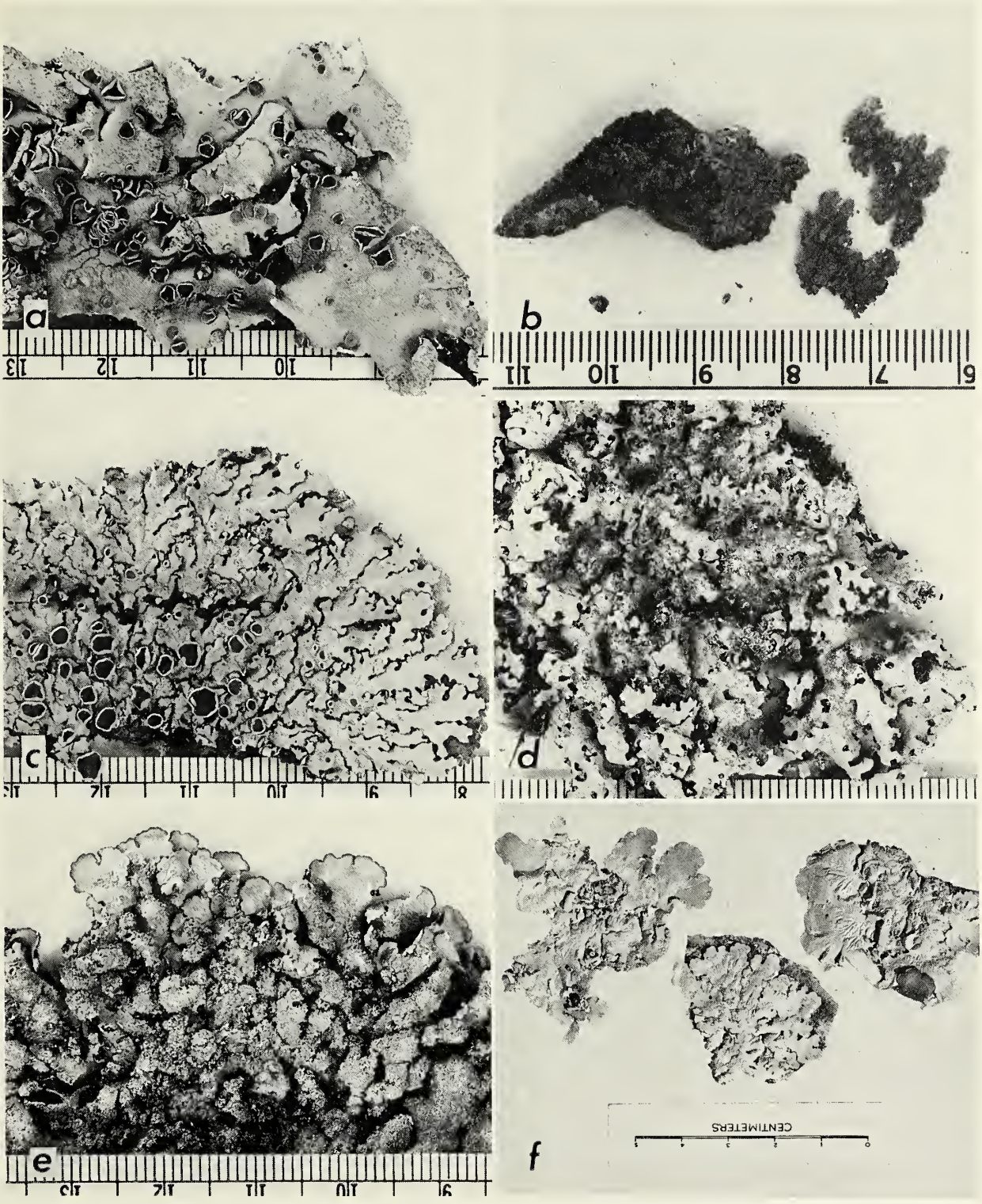

FIGURE 16.—Species of *Parmelina*: *a*, *P. immiscens* (*Arsène* 4456 in US); *b*, *P. indica* (*Hale* 43884); *c*, *P. irrugans* (*Kurokawa* 55342); *d*, *P. jamesii* (*Du Rietz* 3117:3 in US); *e*, *P. leucotyliza* (*Hale* 29402); *f*, *P. lindmanii* (*Malme* 450 in S). (Scale in mm.)

medulla K+, C+, KC+ more intensely yellow, P− (unidentified yellow pigments).

Distribution.—Mexico.

Remarks.—*Parmelina immiscens* is the only species in the genus endemic to Mexico. It occurs rather rarely on trees in open oak-pine forests in the arid highlands (2000–2400 m elevation). Although the medulla is distinctly yellow, no terpenes are produced. The pigment seems to be secalonic acid A but chromatographic tests are inconclusive. This species and its presumptive isidiate morph *P. lindmanii*, therefore, are unrelated to *P. subaurulenta* and similar Asian species with a yellow medulla.

Specimens Examined.—Mexico: Durango, *Cramer* 1998 (KAN, US); Jalisco, *Pringle* 10706 (US); Oaxaca, *Hale* 20825.

20. *Parmelina indica*, new species

Figure 16*b*

Description.—Thallus arcte adnatus, saxicola, obscure albo-cinereus, 2–3 cm latus, lobis sublinearibus, contiguis, 0.8–1.2 mm latis, ciliis margine irregulariter dispersis, simplicibus, 0.1–0.3 mm longis, superne planus, continuus vel rimosus, nitidus, modice vel dense isidiatus, isidiis cylindricis vel leviter inflatis, praecipue simplicibus, usque ad 0.3 mm altis; cortex superior 12 μm crassus, epicorticatus, stratum gonidiale 15–18 μm crassum, medulla alba, 100–120 μm crassa, cortex inferior paraplectenchymatus, 12–14 μm crassus; subtus niger, dense rhizinosus, rhizinis nigris, simplicibus, 0.4 mm longis. Apothecia ignota.

Chemistry.—Cortex K+ yellow (atranorin); medulla negative with color tests zeorin, leucotylin and traces of associated "subaurulenta" terpenes).

Holotype.—On rocks in river below Silver Cascade, Kodaikanal, Tamil Nadu, India, elevation about 1800 m, *M. E. Hale* 43884, 24 January 1975 (US: isotype in Poona).

Distribution.—India.

Remarks.—This small saxicolous lichen was collected on a large rock outcropping in an undisturbed stream bed. Externally it is close to the American *P. obsessa* but lacks both yellow pigments and galbinic acid. It is the only terpene-containing *Parmelina* without pigments.

21. *Parmelia irrugans*, new combination

Figure 16*c*

Parmelia irrugans Nylander, 1890:26 [type collection: Simonoseki, Japan, *Almquist* (H, Nylander herbarium number 35551, lectotype; isolectotype in S)].

Parmelia insinuata Hue, 1899:158 [type collection: Ta-Pin-Tze, Yunnan, China, *Delavay* 3008 (PC, lectotype); not *P. insinuata* Nylander, 1856:324].

Parmelia xanthocarpa Hue, 1899:178 [type collection: Ta-Long-Tan near Ta-Pin-Tze, Yunnan, China, *Delavay* 23 (PC, lectotype)].

Parmelia insinuatula Zahlbruckner, 1929:169 [based on *P. insinuata* Hue].

Description.—Thallus adnate to loosely adnate, corticolous, firm, 4–10 cm broad; lobes sublinear to subirregular with more or less rotund apices, contiguous, 2–5 mm wide, the marginal cilia distinct, mostly in the axils, to 0.8 mm long; medulla pale orange or yellow; lower surface black, densely rhizinate, the rhizines simple or becoming squarrosely branched. Apothecia very common, adnate to sessile, 3–10 mm in diameter; spores 8, 8–10 × 12–15 μm, often poorly developed.

Chemistry.—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylic acid and associated terpenes, and secalonic acid A).

Distribution.—China and Japan.

Remarks.—This species has not been recognized by contemporary lichenologists or included in lists of Asian *Parmelinae*. It is characterized by the presence of the "aurulenta" terpene series, the thin, expanded thallus, and large apothecia (3–10 mm in diameter), invariably larger than those of *P. subaurulenta* (3 mm or less). The spores are slightly but not significantly larger than those in *P. subaurulenta*. As a rule, the size of apothecia will separate the two species. Two of Nylander's syntypes of *P. subaurulenta* (see "Specimens Examined" below) are actually *P. irrugans*.

Parmelina irrugans has a more restricted range than *P. subaurulenta*. It does not occur in India where *P. subaurulenta* is so common. It is, however, more frequent in Japan than one might expect from the specimens examined because I did not borrow the specimens at TNS for redetermination. Many annotated by me in 1964 in Tokyo as *P. homogenes* are probably this species.

Specimens Examined.—China: *Montiguy* (H. Nylander her-

barium number 35668, a syntype of *Parmelia subaurulenta* Nylander); Hunan, *Handel-Mazzetti* 2469 (US, W); Yunnan, *Delavay* (H, Nylander herbarium number 35666). Japan: *Maries* (H, Nylander herbarium number 35667, probable syntype of *Parmelia subaurulenta* Nylander); Prov. Kii, *Kurokawa* 59064 (TNS, US); Prov. Kikuchu, *Kurokawa* 59322 (TNS, US); Prov. Kozuke, *Kurokawa* 58581 (TNS, US); Prov. Mutsu, *Kurokawa* 550341, 55342, 56162, 58582 (TNS, US); Prov. Ohmi, *Hale* 29456, 29470; Prov. Rikuchu, *Kurokawa* 59322 (TNS, US); Prov. Shimane. *Omura* 23 (US); Prov. Suruga, *Culberson* 10738 (DUKE, US).

22. *Parmelina jamesii*, new combination

FIGURE 16*d*

Parmelia jamesii Hale, 1972b:179 [type collection: Wellington, New Zealand, *James* NZ2118 (US, holotype; isotypes in BM, TNS)].

DESCRIPTION.—Thallus adnate on bark, rather fragile, whitish mineral gray, 5–10 cm broad; lobes sublinear, contiguous, 1.5–3.0 mm wide, the margins sparsely ciliate, the cilia irregularly dispersed, long; upper surface plane but becoming rugulose with age, shiny or becoming opaque and white-pruinose at the tips, sometimes faintly white-reticulate, moderately isidiate, the isidia cylindrical, thin, erect, up to 0.3 mm high; lower surface black, moderately rhizinate, the rhizines simple or sparsely squarrosely branched. Apothecia unknown.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K−, C−, KC−, P+ red (fumarprotocetraric acid and a trace of protocetraric acid).

DISTRIBUTION.—Eastern Australia and New Zealand.

REMARKS.—*Parmelina jamesii* is the only species producing β-orcinol depsidone fumarprotocetraric acid. It is also one of the few species endemic to the Australian region. It might be mistaken superficially for a *Hypotrachyna* except that the lobe margins are distinctly ciliate and the rhizines simple.

23. *Parmelina leucotyliza*

FIGURE 16*e*

Parmelina leucotyliza (Nylander) Hale, 1974:482.

Parmelia leucotyliza Nylander, 1890:27 [type collection: Rockosan, Japan, *Almquist* (H, Nylander herbarium number 35196, lectotype; isolectotype in S)].

Parmelia fraudans ssp. *subfraudans* Zahlbruckner, 1927:352 [type collection: Inokashira, near Tokyo, Japan, *Asahina* 23a (W, lectotype)].

Parmelia leucotyliza f. *rugulosa* Asahina, 1952:94 [type collection: Mt. Higane, Prov. Suruga, Japan, *Yamashita* 17 (TNS, lectotype)].

Parmelia leucotyliza f. *sublaevis* Asahina, 1952:95 [type collection: Kadoike, Prov. Suruga, Japan, *Asahina* (TNS, lectotype)].

DESCRIPTION.—Thallus adnate to loosely attached on bark or rocks, light greenish mineral gray, 8–12 cm broad; lobes sublinear to subirregular, contiguous, 2–4 mm wide, the marginal cilia mostly in lobe axils, about 0.5 mm long; upper surface shiny or becoming dull white pruinose at the tips, plane but soon becoming pustulate, the pustules breaking open and coalescing into large clumps without formation of soredia; medulla very pale salmon colored to white; lower surface black except for a dark brown zone at the tips, densely rhizinate, the rhizines black and shiny, simple or sparsely squarrosely branched. Apothecia rare, substitpitate, the amphithecium pustulate, 1–3 mm in diameter; spores 8, 6 × 11–12 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylin and related "subaurulenta" terpenes, secalonic acid A, and traces of unidentified substances).

DISTRIBUTION.—Japan and Malaysia (Sabah).

REMARKS.—Originally when studying the Japanese *Parmeliae*, I synonymized *P. leucotyliza* under *P. aurulenta*. These two species, however, are different in several important respects. First, they have different terpene chemistry. Second, the pustules of *Parmelina leucotyliza* do not become sorediate, whereas those in *P. aurulenta* are often densely sorediate. Lastly, *P. leucotyliza* is restricted to Japan except for a tentatively identified specimen from Sabah. It seems to be much more common than *P. aurulenta* in Japan, occurring on rocks and trees in open forests, trees along roads, and rocks in rice fields.

SPECIMENS EXAMINED.—Japan: Prov. Aki, *Hale* 29535, 29445, 29544; Prov. Hyuga, *Hale* 29677; Prov. Iwaki, *Kurokawa* 58079 (TNS, US); Prov. Izu, *Asahina* in *Lichenes Japoniae Exsiccati* 139 (US), *Kurokawa* 58004, 58600 (TNS, US); Prov. Kazusa, *Kurokawa* 59002 (TNS, US); Prov. Kii, *Kurokawa* 59087, 59131, 59132 (TNS, US); Prov. Musashi, *Kurokawa* 51040 (TNS, US); Prov. Settsu, *Hale* 29402, 29433; Shizuoka Prefecture, *Omura* 157 (US). Malaysia: Sabah, *Hale* 29102.

24. *Parmelina lindmanii*

FIGURE 16*f*

Parmelina lindmanii (Lynge) Hale, 1974:483.

Parmelia lindmanii Lynge, 1914:74 [type collection: Porto Alegre, Rio Grande do Sul, Brazil, *Malme* 450 (S, lectotype)].

Parmelia tiliacea var. *sulphurosa* f. *asperata* Müller Argoviensis, 1883:46 [type collection: Argentina, *Balansa* 5 (G, lectotype)].

DESCRIPTION.— Thallus adnate on bark, pale buff to yellowish mineral gray, 5–8 cm broad; lobes subirregular, apically rotund, 3–5 mm wide, the marginal cilia mostly in lobe axils, less than 0.5 mm long; upper surface plane to rugose with age, shiny, moderately to densely isidiate, the isidia cylindrical, unbranched, to 0.3 mm high; medulla uniformly pale sulfur-yellow tinged with orange; lower surface black except for a narrow marginal brown zone, moderately rhizinate, the rhizines black, simple. Apothecia rare, sessile, 2–5 mm in diameter; spores 8, 6–10 × 9–14 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla more intensely yellow with K and C, P− (probably secalonic acid A and unidentified pigments).

DISTRIBUTION.—Mexico and South America.

REMARKS.—This corticolous lichen is characterized by the pale yellow-orange medulla and the isidia. It is probably the isidiate morph of the Mexican endemic *P. immiscens*. When I first began study of *Parmelia*, I confused *Parmelina lindmanii* and *Parmelia endosulphurea* (= *Parmotrema endosulphureum* (Hillmann) Hale) (Hale, 1960:20). Both species have a yellow-orange medulla and isidia, but *P. lindmanii* has more adnate lobes, cilia in the axils, and no gyrophoric acid. Both species lack terpenes.

SPECIMENS EXAMINED.—Mexico: Querétaro, *Nakanishi* 257 (US); Tamaulipas, *Nakanishi* 106 (US); Vera Cruz, *Hale* 19389, 19685. Colombia: Antioquia, *Nee and Mori* 4258 (US). Venezuela: Mérida, *Rodrigues* 168 (US). Brazil: Rio Grande do Sul, *Lima* 3 (US). Paraguay; Caacupe, *Balansa* (G, H). Uruguay: Durazno, *Osorio* 2772 (DUKE, UPS); Lavalleja, *Osorio* 3822 (MVM, US); Paysandú, *Lamb* (BM, H); Soriano, *Rosengurtt* (H); Trinidad, *Osorio* 3603 (LD). Argentina: *James* (BM); Buenos Aires, *Santesson* 58, 100, 446 (S).

25. *Parmelina melanochaeta*

FIGURE 17*a*

Parmelina melanochaeta (Kurokawa) Hale, 1974:483.

Parmelia melanochaeta Kurokawa in Hale and Kurokawa, 1964:133 [type collection: Santa Anna de Chapada, Mato Grosso, Brazil, *Malme* 2243 (S, lectotype; isolectotypes in UC, US)].

DESCRIPTION.—Thallus adnate on bark, turning olive-buff to cream-buff in the herbarium, 4–7 cm in diameter; lobes irregularly branched, sometimes sublinear-elongate, 2–6 mm wide, the margins more or less crenate, ciliate, the cilia black, mostly simple, 1–2 mm long; upper surface shiny, maculate, moderately to densely isidiate, isidia thin, cylindrical, usually branched, often with black spinules or short cilia; medulla white; lower surface black, dark to pale brown in a rather wide zone near the tips, moderately rhizinate, rhizines black to blackish brown, simple. Apothecia adnate to substipitate, 1–3 mm in diameter, the amphithecium isidiate, spinulate, the disc vandyke-brown; spores 8, 8–10 × 13–15 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K−, C+, KC+ rose, P− (gyrophoric acid).

DISTRIBUTION.—South America.

REMARKS.—This species is very close to *P. dissecta* in general morphology and has the same chemistry. The lobes, however, are much broader, the isidia ciliate, the marginal cilia long and distinct, and the upper cortex strongly white-maculate. It occurs in a rather restricted area from Brazil into Paraguay with one specimen recorded from Colombia.

SPECIMENS EXAMINED.—Colombia: Cundinamarca, *Flenniken* 1745 (US). Brazil: Mato Grosso, *Malme* 2397B (S). Paraguay: Asunción, *Schinini* 17333 (MVM); Gran Chaco, *Malme* (S). Additional records from Brazil and Paraguay are listed in Hale and Kurokawa, 1964:133.

26. *Parmelina metarevoluta*

FIGURE 17*b*

Parmelina metarevoluta (Asahina) Hale, 1974:483.

Parmelia metarevoluta Asahina, 1960:97 [type collection: Azusayama, Prov. Shinano, Japan, *Nuno and Kurokawa* 59243 (TNS, lectotype; isolectotype in US)].

DESCRIPTION.—Thallus adnate on bark or rock, pale olive-buff, 2–6 cm in diameter; lobes dichotomously branched, sublinear-elongate, more or less ascending at the tips, 1–4 mm wide, lobules sometimes present on older lobes, the margins more or less crenate, narrowly black rimmed, ciliate, the cilia black, shiny, simple, 0.2–0.5 mm long; upper

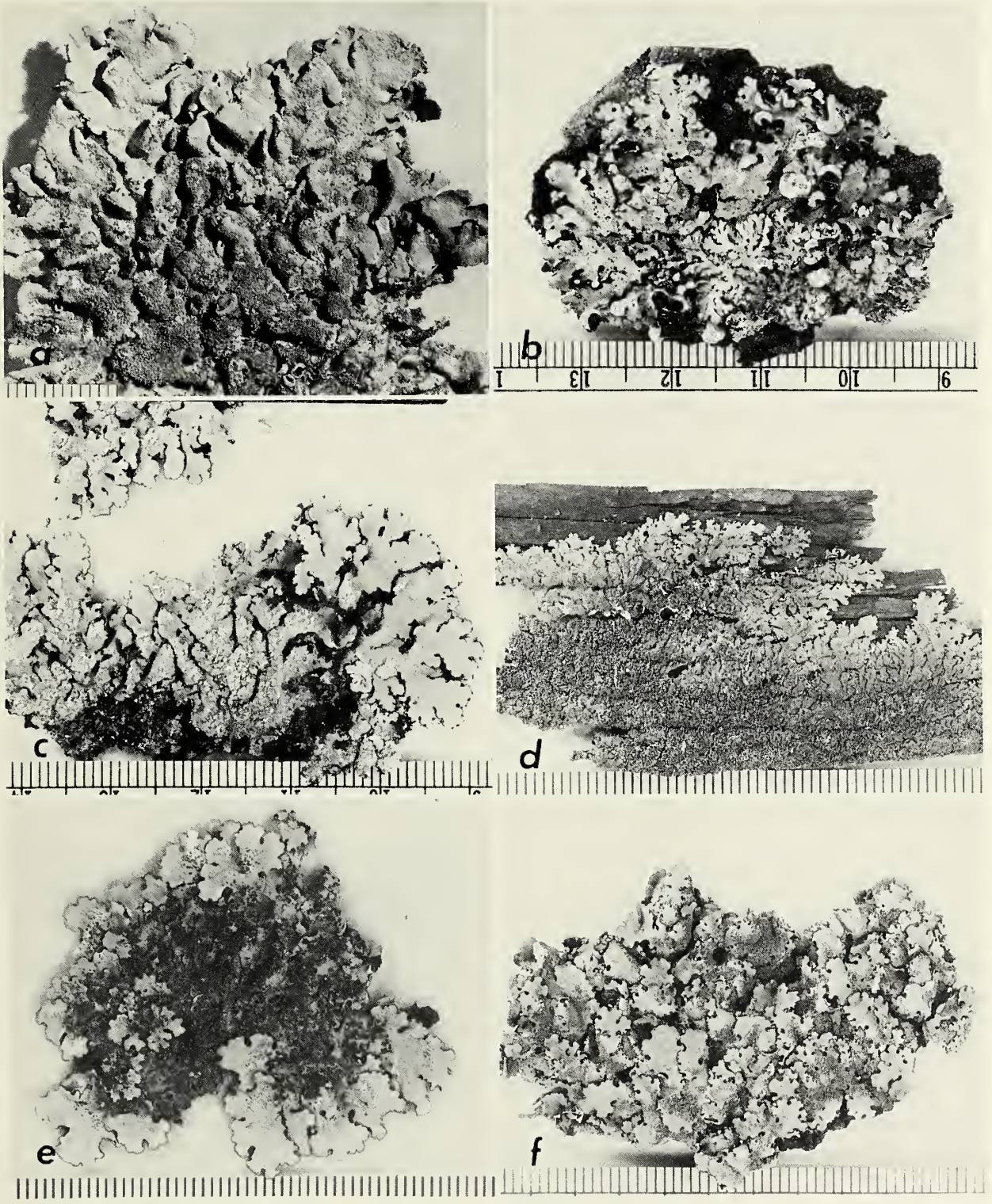

FIGURE 17.—Species of *Parmelina*: *a*, *P. melanochaeta* (*Malme* 2243 in S); *b*, *P. metarevoluta* (*Kurokawa* 59180 in US); *c*, *P. muelleri* (*Hale* 42277); *d*, *P. obsessa* (*Hale* 19186); *e*, *P. pastillifera* (specimen in US); *f*, *P. perisidians* (*Togashi* in US). (Scale in mm.)

surface smooth and shiny, not maculate, more or less rugose on older lobes, sorediate, soralia subterminal, capitate, pale orange below; lower surface black, densely rhizinate; the rhizines black, shiny, simple, about 0.5 mm long. Apothecia very rare, adnate, 1–5 in diameter, the rim more or less crenate, sorediate, the disc dark brown; spores 8, 7 × 10–12 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K+ reddish, C−, KC−, P+ orange (galbinic acid, rarely constictic acid, trace of salazinic acid, zeorin, leucotylin and associated terpenes, and secalonic acid A).

Distribution.—Eastern United States, Japan, and China.

Remarks.—As pointed out by Kurokawa (1968b: 351), this is the sorediate morph of *P. galbina*. It was first collected and correctly identified in the United States by Dr. Satoshi Nakanishi in 1971. Two additional collections have since been identified, one of them (*Plitt* 236) filed under *Physcia orbicularis,* which is very superficially similar in lobe configuration and capitate soralia. It has the same Arcto-Tertiary distribution pattern as *P. galbina* but is extremely rare in North America.

Specimens Examined.—United States: Ohio, *Wetmore* 18051 (MINN, US); Maryland, *Plitt* 236 (US); Tennessee, *Nakanishi* 238 (US). Japan: Prov. Bungo, *Kurokawa* 62329 (TNS); Prov. Ise, *Asahina* (TNS); Prov. Omi, *Asahina* (TNS); Prov. Shinano, *Asahina* (TNS). *Kurokawa* 58326 (TNS); 59180 (TNS, US) 59243, 59244 (TNS); Prov. Suruga, *Asahina* (TNS); Prov. Totomi, *Asahina* 160 (TNS); Prov. Yamashiro, *Asahina* (TNS). China: Manchuria, *Asahina* 29 (TNS).

27. *Parmelina muelleri*

Figure 17*c*

Parmelina muelleri (Vainio) Hale, 1974:483.

Parmelia muelleri Vainio, 1890:49 [type collection: Sitio, Minas Gerais, Brazil, *Vainio* in *Lichenes Brasilienses Exsiccati* 948 (TUR, Vainio herbarium number 2677, lectotype; isolectotypes in BM, FH, M, UPS)].

Description.—Thallus closely adnate on bark, lichen green, turning honey yellow in the herbarium, 5 cm or more in diameter; lobes irregularly branched, rounded at the tips, 2–3 mm wide, the margins evenly ciliate, the cilia simple or rarely branched, black, shiny, up to 1.5 mm long; upper surface strongly white-maculate, irregularly cracked on older lobes, sorediate, soredia laminal, more or less granular, the soralia round, separate; lower surface uniformly black, moderately rhizinate, the rhizines simple, black. Apothecia rare, sessile, the amphithecium sorediate, disk brick red, 2–5 mm in diameter; spores 8, 7–10 × 12–15 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K+ persistent yellow, C−, KC−, P+ pale orange (stictic acid with or without constictic acid).

Distribution.—Mexico and South America.

Remarks.—When I first collected this species on shade trees in a coffee plantation in Venezuela, I identified it tentatively as *P. pilosa* because of the laminal soralia and distinct white maculae. Chemical tests, however, showed that it contained stictic acid and would have to be identified with *P. muelleri*. After comparing the two species in the herbarium, I concluded that *P. pilosa* is larger and more robust on the average, but the two are very closely related. Vainio (1890) had in fact compared *P. muelleri* with *Parmelia balansa* f. *sorediata* (= *Parmelina pilosa*) which he distinguished with a negative K test. They have different geographic ranges, *P. muelleri* being more common in northern South America and possibly occurring at a higher elevation than *P. pilosa*. There is no esorediate, stictic acid-containing parent morph comparable to the *P. consors–P. pilosa* species pair.

Specimens Examined.—Mexico: Michoacán, *Wirth* 329 (US); Vera Cruz, *Hale* 21124. Venezuela: Mérida, *Hale* 42219, 42230, 42256, 42277, *Oberwinkler and Poelt* 7529 (M, US); Táchira, *Hale* 45716. Peru: Cuzco, *Iltis* 3214 (WIS). Argentina: Tucumán, *Culberson* 14909 (DUKE, US).

28. *Parmelina obsessa*

Figure 17*c*

Parmelina obsessa (Acharius) Hale, 1974:483.

Parmelia obsessa Acharius, 1814:195. [type collection: North America (?Pennsylvania), *Muhlenberg* (H-Ach, lectotype; isolectotype in PH)].

Parmelia finkii Zahlbruckner in Hedrick, 1934:162 [type collection: Williamsville, Wayne County, Missouri, *Russell* (W, lectotype; isolectotype in MICH)].

Description.—Thallus closely adnate on rock (rarely on bark), pale smoke gray to light mineral gray, 3–6 cm broad; lobes irregularly branched, sublinear, contiguous, 1–2 mm wide, the margins dissected, sparsely ciliate, especially in axils, the cilia black, simple, to 0.3 mm long; upper surface densely isidiate, the isidia cylindrical, sometimes

branched; medulla white to pale dull green-yellow; lower surface black, sparsely to moderately rhizinate, dark brown and short rhizinate near the tips, the rhizines simple. Apothecia adnate, 1–3 mm in diameter, the disc brown, the amphithecium isidiate; spores 8, 4–5 × 6–10 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, galbinic acid, trace of salazinic acid, leucotylin and associated terpenes, and secalonic acid A).

DISTRIBUTION.—Eastern United States.

REMARKS.—*Parmelina obsessa* is another Acharian species that had been lost from the literature since 1814. Not only were extremely few collections available, but also many were incorrectly identified. One in US was listed as "Parmelia prolixa," and as recently as 1958 *P. obsessa* was identified as *Parmelia finkii* (Hale, 1958:82). Recent collecting by American lichenologists, however, has shown that it is extremely common on sandstone outcrops in closed oak forests and can tolerate considerable shade. As a closely appressed saxicolous lichen it is not easy to collect. Kurokawa (1968b) correctly recognizes it as the isidiate morph of *P. galbina*. No comparable isidiate population has evolved in Japan.

SPECIMENS EXAMINED (Selected).—New Hampshire, *Willey* (US); Pennsylvania, *Hale* 16288, 17486; Maryland, *Hale* 14422; West Virginia, *Hale* 10311, 10660, 12408, 15003; Kentucky, *Hale* 13866; Indiana, *Hale* 14182; Illinois, *Hale* 13935, 14022; Michigan, *Hale* 33889; Wisconsin, *Hale* 23529; Minnesota, *Hale* 23602; Virginia, *Hale* 12018, 18803, *Luttrell* 3864 (US), *Tucker* 6588 (US); North Carolina, *Culberson* 6491, 10418 (DUKE, US), *Hale* 16358; Tennessee, *Hale* 37083; South Carolina, *Hale* 7698; Georgia, *Hale* 7404, 30605; Alabama, *Hale* 7098; Louisiana, *Hale* 33862; Arkansas, *Hale* 2972, 4030; Kansas, *Hale* 4749; Oklahoma, *Hale* 4886, 5054, *Keck* 1453 (US); Texas, *Hale* 5452.

29. *Parmelina pastillifera*, new combination

FIGURE 17*e*

Parmelia scortea var. *pastillifera* Harmand, 1910:558 [type collection: Bussang, Vosges, France, *Claudel and Harmand* in *Lichenes Gallici Exsiccati* 491 (H, lectotype; isolectotypes in BM, BPI)].

Parmelia pastillifera (Harmand) Schubert and Klement, 1966:58.

DESCRIPTION.—Thallus largely as in *P. tiliacea* (p. 48) except isidia dark tipped, peltate, and apically flattened (Figures 3*e,f*, 4*b*).

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K−, C+, KC+ red, P− (lecanoric acid).

DISTRIBUTION.—Great Britain and Europe.

REMARKS.—While this species has long been recognized as a distinct variety (Poelt, 1961:194), it was only recently raised to species level. Dobson and Hawksworth (1976) have compared it in detail with the normally isidiate *P. tiliacea*, finding that *P. pastillifera* has, on the average, somewhat narrower lobes (2–6 mm) than *P. tiliacea* (3–8 mm) and denser rhizines.[2] *Parmelina pastillifera* also has a somewhat smaller, slightly more bluish thallus. The ecological differences are pronounced, for *P. pastillifera* occurred in England west of the 813 mm rainfall isopleth and the 2°C January mean isotherm. This agrees with Schauer's (1965:80) definition of *P. pastillifera* as an oceanic species in central Europe.

SPECIMENS EXAMINED.—Europe: France, *Lambinon* in *Lichenes Selecti Exsiccati* 363 (LD, US); Germany, *Schröppel* in *Lichenes Alpium* 143 (US); Austria, *Strasser* in *Cryptogamae Exsiccatae Vindobonensi* 3062b (US); Yugoslavia, *Vězda* in *Lichenes Selecti Exsiccati* 762 (US).

30. *Parmelina perisidians*

FIGURE 17*f*

Parmelia perisidians (Nylander) Hale, 1974:483.

Parmelia perisidians (Nylander, 1900:6 [type collection: Rampodde, Ceylon, *Almquist* (S, lectotype; isolectotype in H, Nylander herbarium number 35673)].

Parmelia subsulphurata Asahina, 1951a:228 [type collection; Higashi-Shirakawa, Prov. Mino, Japan, *Yasue* (TNS, lectotype)].

DESCRIPTION.—Thallus adnate on bark, greenish mineral gray, 3–6 cm in diameter; lobes sublinear, 0.5–2 mm wide, the marginal cilia mostly in the axils; upper surface plane, continuous, densely isidiate, the isidia simple or branched; medulla sea-foam yellow; lower surface densely rhizinate, the rhizines black, simple or squarrosely branched. Apothecia adnate, 2–5 mm in diameter, the amphithecium isidiate; spores 8, 5–7 × 7–11 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K+, C+ KC+ more intensely yellow, P−, (zeorin, leucotylin and related terpenes, and secalonic acid A).

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[2] I wish to thank Dr. Hawksworth for allowing me to see his manuscript before publication.

Distribution.—Southeast Asia from India to Japan.

Remarks.—This densely isidiate species is closely related to *P. amagiensis* and may represent its isidiate morph, although differences in pigments, so far unresolved, may exclude this possibility. Both species have the typical "subaurulenta" terpene series. *Parmelina perisidians* has a broad distribution in the higher elevation forests of tropical Asia and the temperate forests of Japan.

Specimens Examined.—India: Karnataka, *Patwardhan* 74.3283 (Poona, US); Tamil Nadu, *Hale* 40101, 40102, *Togashi* (TNS, US). Sri Lanka: see Kurokawa and Mineta (1973:74) for records in Ceylon. Thailand: *Kurokawa* 1818 (TNS, US). Philippines: Mountain Province, *Hale* 26166a. Japan: Prov. Kozuke, *Asahina* (TNS); Prov. Musashi, *Asahina* (TNS); *Kurokawa* 550009 (TNS, US), 64284, 64285 (TNS); Prov. Settsu, *Togashi* (TNS, US).

31. *Parmelina phlyctina*

Figure 18*a*

Parmelina phlyctina (Hale), Hale, 1974.483.

Parmelia phlyctina Hale, 1959:129 [type collection: Blue Mountains, Jamaica, *Imshaug* 14908 (MSC, holotype; isotype in US)].

Description.—Thallus adnate to loosely adnate on bark, membranous and fragile, light mineral gray but turning pink in the herbarium if improperly dried, 5–15 cm broad; lobes subirregular, apically rotund, 5–10 mm wide, the margins entire to lobulate, sparsely ciliate in the lobe axils, the cilia up to 0.5 mm long; upper surface plane, smooth to rugose in older parts, upper cortex fragile and flaking off in small pieces, isidia and soredia lacking; lower surface black except for a narrow brown zone at the tips, sparcely rhizinate, the rhizines simple. Apothecia rare, adnate, 3–8 mm in diameter; spores 8, 3–5 × 7–8 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K+ yellow turning red, C−, KC−, P+ orange (norstictic and connorstictic acids).

Distribution.—Mexico and the West Indies.

Remarks.—Since my discription of this species in 1959, additional collections have been made in Mexico, Cuba, and other islands in the West Indies. It occurs in wet upland rain forests or secondary mist forests. The main distinguishing features are the fragile thallus with a flaking cortex, presence of norstictic acid, and small spores. It is closely related to isidiate *P. antillensis* but is not the direct parent morph since *P. antillensis* has a continuous cortex. It is not, as implied in my original description, a member of *Amphigymnia* (= *Parmotrema*) because the thallus is adnate overall, cilia are produced in the axils, and the bare zone at the margins below is very narrow. Both *P. phlyctina* and *P. antillensis*, however, constitute an anomolous element in *Parmelina*, not only because of the somewhat amphigymnioid lobation but also because of the production of norstictic acid.

Specimens Examined.—Mexico: Chiapas, *Hale* 20202 (S, US), Cuba: Oriente, *Imshaug* 27174 (MSC, US), 25146, 25148 (MSC), *Morton* 9394 (US). Jamaica: *Imshaug* 14614, 14714, 15211, 15362, 15375, 15458, 15502, 15524, 15536 (MSC), 13179, 14727, 15146, 15453, 15513 (MSC, US). Haiti: Sud, *Wetmore* 3373 (MSC). Dominican Republic: Cordillera Central, *Wetmore* 3728 (LD, MSC), 3738 (MSC, US). Puerto Rico: *Imshaug* 29562 (MSC).

32. *Parmelina pilosa*

Figure 18*b*

Parmelina pilosa (Stizenberger) Hale, 1974:483.

Parmelia pilosa Stizenberger, 180:165 [type collection: Rhenoster River, Taaibosch Kranz Mountains, Orange Free State, Union of South Africa, *Rehmann* (ZT, lectotype; isolectotype in H)].

Parmelia balansae var. *sorediata* Müller Argoviensis, 1888a:2 [type collection: Montevideo, Uruguay, *Arechavaleta* (G, lectotype)].

Parmelia subbalansae Gyelnik, 1931:288 (based on *Parmelia balansae* var. *sorediata* Müller Argoviensis.

Description.—Thallus adnate to loosely attached on bark, coriaceous, light buff mineral gray, 5–12 cm broad; lobes subirregular, apically subrotund, the marginal cilia coarse, becoming furcate, 0.5–1.0 mm long; upper surface shiny and heavily white-maculate, plane to minutely pitted, sorediate, the soralia orbicular, about 0.5 mm in diameter, separate or coalescing into extensive laminal sorediate areas; medulla white; lower surface black, densely rhizinate, coarse and fine rhizines intermixed, simple to sparcely furcate. Apothecia rare, substipitate; spores not seen.

Chemistry.—Cortex K+ yellow (atranorin); medulla negative with color reagents (no substances demonstrated).

Distribution.—South America and southern Africa.

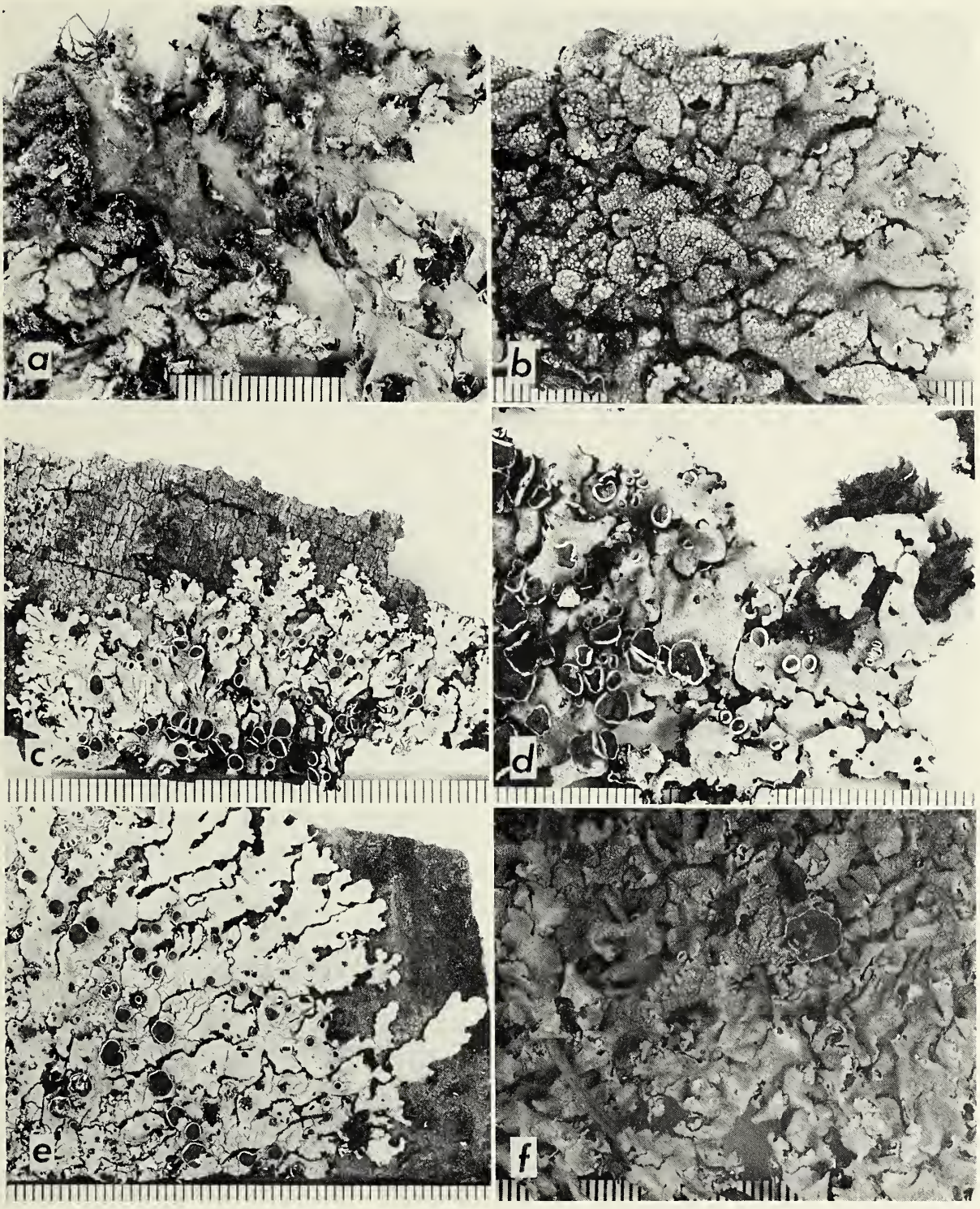

FIGURE 18.—Species of *Parmelina: a, P. phlyctina* (*Imshaug* 13179 in US); *b, P. pilosa* (*McOwan* in US); *c, P. pruinata* (*Kurokawa* in *Lichenes Selecti Exsiccati* 81 in US); *d, P. quercina* ("carporrhizans" population) (*Schroppel and Poelt* in *Lichenes Alpium* 8 in US); *e, P. quercina* (*Tavares* 1082 in US); *f, P. rhytidodes* (*Kurokawa* 58601 in US). (Scale in mm.)

Remarks.—*Parmelina pilosa* is the sorediate morph of *P. consors*. It occurs on a variety of trees (*Celtis, Erythina, Scutia*), even on fence posts, and in open or secondary habitats up to 2000 m elevation. It must be distinguished carefully from *P. muelleri*, which rarely occurs in this range and contains stictic acid.

Specimens Examined.—Ecuador: Pichincha, *Wiggins* 38945 (COLO). Uruguay: Canelones, *Felippone* 434 (G); Durazno, *Osorio* 2979 (DUKE); Flores, *Osorio* 3519 (MVM, US); Florida, *Osorio* 1299 (F); Minas, *Osorio* 2049, 2056 (MVM, US); Soriano, *Rosengurth* (H). Argentina: Buenos Aires, *Grassi* 719 (US), *Santesson* 75 (S), *Schnyder* (G), *Venturi* 2853 (SI); Cordoba, *Giardelli* 1025 (SI), *Petersen* 23 (S); Entre Rios, *Santesson* 126 (S, US); Salta, *Fries* 21 (S), *James* (BM), *Lorentz* (M). Chile: Valparaiso, *Santesson* 3084 (S). Kenya: Nyanza Province, *Maas Geesteranus* 4957 (L, US). Rhodesia: *Höeg* (TRH). Union of South Africa: Basutoland, *Kofler* (LD); Cape Province, *Höeg* (LD, TRH), *Kofler* (LD), *McOwan* (BM, US); Natal, *Höeg* (TRH).

33. *Parmelina pruinata*

Figure 18*c*

Parmelina pruinata (Müller Argoviensis) Hale, 1974:483.
Parmelia pruinata Müller Argoviensis, 1883:46 [type collection: Yorke Peninsula, Australia, *Tepper* (G, lectotype)].
Parmelia tiliacea var. *affixa* Stirton, 1899:485 [type collection: Queensland, Australia, *Bailey* (?) 376 (BM, lectotype)].

Description.—Thallus closely adnate on twigs, ashy white, 1–5 cm broad; lobes sublinear-elongate, variable, 1–3 mm wide, marginal cilia sparse, mostly in lobe axils, up to 0.5 mm long; upper surface plane to convex, rugulose, more or less pruinose; medulla white; lower surface black, sparsely rhizinate, the rhizines black, simple. Apothecia conspicuous, adnate, 2–4 mm in diameter, the disc often pruinose; spores 8, 7–8 × 10–12 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K−, C+, KC+ red, P− (lecanoric acid).

Distribution.—Australia and New Zealand.

Remarks.—This species is rather variable in lobe configuration and width but typically grows closely adnate on small twigs and branches of trees in arid scrub land. It has no apparent relation with *P. quercina*, the only other nonsorediate, lecanoric acid-containing species in the genus, characterized by much coarser lobes and white maculae in the cortex. Müller mentions "subtus alba" in his original description, but he was actually describing a *Physcia* species growing intermingled with the type. The marginal cilia are sparse and sometimes difficult to determine. It could, in fact, be misidentified as a *Pseudoparmelia* but no corticolous nonisidiate species of that genus with lecanoric acid are presently known.

Specimens Examined.—Australia: Australian Capital Territory, *Kurokawa* in *Lichenes Rariores Selecti Exsiccati* 81 (US). *Leuthner* (US); New South Wales, *Boorman* 1387, L1389 (NSW), *Doing* (L, US), *McVean* 6358 (COLO), *Weber and McVean* L–47913, L–49886 (COLO, US). *Wilson* 96 (NSW); Queensland, *Gwytherl* (BM); South Australia, *Rogers* 886 (US); Tasmania, *Bratt* 1380b (US), *James* 2117 2125 (BM, US), *Weymouth 65* (BM, US), 432 (BM); Victoria, *Filson* 6639, 7004 (US), *James* 223 (BM, US). New Zealand: *Mason* 90 (BM).

34. *Parmelina quercina*

Figure 18*d,e*

Parmelina quercina (Willdenow) Hale, 1974:483.
Lichen quercinus Willdenow, 1787:353 [type collection: Thiergarten and near Tegel, Germany (not seen; illustrated in pl. 7: fig. 13)].
Imbricaria quercina (Willdenow) de Lamarck and de Candolle, 1805:389.
Parmelia carporrhizans Taylor, 1847:163 [type collection: Canary Islands, *Lemann* (FH–Tayl, lectotype)].
Parmelia sinuosa var. *hypothrix* Nylander, 1856:301 [type collection: Pyrenees, France, *Nylander* (H, lectotype)].
Parmelia atricha Nylander, 1873:271 [type collection: La Preste, Pyrenees, France, *Nylander* 16 (H, lectotype (not seen); isolectotypes in FH, BM)].
Parmelia tiliacea var. *hypothrix* (Nylander) Müller Argoviensis, 1888b:196.
Parmelia revoluta var. *granulata* Harmand, 1897:221 [type collection: Docelles, Vosges, France, *Harmand* 284 (DUKE, lectotype)].
Parmelia quercina (Willdenow) Vainio, 1899:279.
Parmelia budapestinensis Gyelnik, 1932b:212 [type collection: Budapest, Hungary, *Timkó* (BP, holotype)].
Parmelia carporrhizans f. *malicola* Gyelnik, 1932b:212 [type collection: St. George, Hungary (Austria?), *Zahlbruckner* (BP. holotype)].
Parmelia yalungana Zahlbruckner, 1934b:206 [type collection: between the Litang and Yalung rivers between Muli Gomba, Baurong, and Wa-Erh-Dje, Szechuan, China, *Rock* 16720 (W, lectotype)].

Description.—Thallus closely adnate on bark, rarely on rock, rather coriaceous, light olive-gray, sometimes turning olive-buff in the herbarium, 5–10 cm broad; lobes dichotomously or irregularly branched, sublinear, separate or becoming imbricate, 1.5–4.5 mm wide, the margins smooth to more or less crenate, often narrowly black rimmed,

moderately to densely ciliate, the cilia black, simple, 0.2–1 mm long; upper surface smooth and shiny, faintly to strongly white-maculate, irregularly rugose and cracked on older lobes, sometimes partly pruinose, isidia and soredia lacking; lower surface black, densely rhizinate, the rhizines black, shiny, simple or more rarely squarrose, 1–3 mm long. Apothecia numerous, substipitate, 1.5–5 mm in diameter, the amphithecium smooth or retrorse-rhizinate, the disc burnt umber; spores 8, 5–7 × 6–10 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K−, C+ KC+ red, P− (lecanoric acid).

Distribution.—California, Europe, Pakistan, Nepal, eastern Asia, and Australia.

Remarks.—As a common member of the European foliose lichen flora this was one of the first species of *Parmelia* to be described. The records from eastern North America previously identified as *Parmelia quercina* are now recognized as *Parmelina galbina* or *Hypotrachyna livida* (Taylor) Hale. The interesting distribution pattern, centered in western North America and Europe, is typical of the Mediterranean type, although the species occurs less commonly in eastern Asia and Australia. Still this is a remarkably broader range than its isidiate morph *P. tiliacea*.

The development of rhizines on the lower side of the apothecia has been used to justify a separate population, called *Parmelia carporrhizans*. As W. Culberson (1961:168) points out, however, virtually all specimens in California have these rhizines, and many European specimens identified as *P. quercina* are often found to have them, sometimes only very sparsely developed (Dobson and Hawksworth, 1976). This trait does not seem to warrant specific status, although Schauer (1965:71) found this population to have a strongly oceanic distribution pattern in western Europe. The problem will have to be solved through careful field studies in Europe.

Specimens Examined (selected).—*Without Retrorse Rhizines:* Europe: Denmark, *Rostrup* (LD); Germany, *Schröppel and Poelt* in *Lichenes Alpium* 7 (H, LD, US); Switzerland, *Mereschkovsky* (US), *Seifriz* (US); Austria, *Eggerth* in *Flora Exsiccata Austro-Hungarica* 1542 (US); Czechoslovakia, *Vězda* in *Lichenes Bohemoslovakiae Exsiccati* 201 (LD, US); Hungary, *Timkó* in *Lichenotheca* 135 (H, LD); Spain, *Schindler* 4303 (KR, US); Portugal, *Tavares* 1082 (US). Pakistan: *Iqbal* 180 (US). Nepal: *Stainton* 4098 (BM, US). China: Manchuria, *Asahina* 28 (TNS); Shensi Prov., *Hugh* (BM). Japan: Prov. Hyuga, *Hale* 29650, *Kurokawa* 65065 (TNS); Prov. Tango, *Asahina* (TNS); Prov. Tosa, *Kurokawa* 64091 (TNS), 64094 (TNS, US). Australia: New South Wales, *Du Rietz* 577b (UPS, US), *Flockton* 884 (US).

Mostly with Retrorse Rhizines on the Apothecia: United States: See W. Culberson (1961:172) for a list of specimens examined and a distribution map. Europe: England, *Borrer* (US), *Crombie* (BM, US), *Holl 15* (BM), *James* 75 (BM); France, *Crozals* (US), *Roudon* in *Lichenes Selecti Exsiccati* 268 (US); Spain, *Bauza* (LD); Portugal, *Tavares* in *Lichenes Lusitaniae Selecti Exsiccati* 217 (US); Germany, *Poelt* in *Lichenes Alpium* 8; Switzerland, *Barkman* 4294a (UPS); Austria, *Steiner* in *Cryptogamae Exsiccatae Vindobonensi* 4134 (F, NY); Italy, *Almborn* (LD), *Baumgartner* in *Cryptogamae Exsiccatae Vindobonensi* 3165 (NY, US). Tunisia: *Runemark* (LD).

35. *Parmelina rhytidodes*, new species

Figure 18*f*

Description.—Thallus adnatus vel laxe adnatus, corticola et saxicola, pallide olivaceo-cinereus, 8–12 cm latus, lobis subirregularibus, imbricatis congestisque, 2–4 mm latis, margine irregulariter ciliatis, ciliis nigris, 0.3–0.6 mm longis; superne nitidus vel apicem versus albo-pruinosus, primum planus sed mox dense et omnino rugosus (Figure 6*b*), rugis non eruptentibus, cortice integro vel rare rumpente; cortex superior 12–14 μm crassus, epicorticatus, stratum gonidiale 14–16 μm crassum, medulla pallide salmonea, 110–150 μm crassa, cortex inferior brunneus, paraplectenchymatus, 15–17 μm crassus; subtus niger, dense rhizinosus, rhizinis nigris vel apice brunneis, simplicibus vel sparse squarroso-ramosis. Apothecia numerosa, sessilia vel substipitata, disco plano, 3–8 mm diametro; sporis 8, 9–11 × 12–14 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylic acid and related terpenes, secalonic acid A, and traces of unidentified substances).

Holotype.—Amagi Pass, Prov. Izu, Japan, *S. Kurokawa* 58601, 1 December 1958 (US, holotype; isotype in TNS).

Distribution.—Japan and Nepal.

Remarks.—After I had examined specimens identified as *Parmelina entotheiochroa* with thin-layer chromatography, there remained a small group with the "aurulenta" terpene profile. On further study I found that these are morphologically different from typical *P. entotheiochroa* in that the ridges which develop very densely do not burst open or

flake off. While *P. rhytidodes* can be recognized with practice from the external morphology alone, a chemical test is desirable for confirmation. The species is probably not as common in Japan as *P. entotheiochroa*, but I have not had the opportunity to re-examine the numerous specimens in TNS with chromatography. The collections made by Poelt in Nepal are tentatively placed here. They are very densely rugose and have crowded lobes, modified ecologically by the high exposed elevation where they were collected. *Parmelina rhytidodes* is apparently an offshoot with sorediate *P. aurulenta* from *P. irrugans* or a now extinct parent morph similar to it.

Specimens Examined.—Japan: Prov. Awa, *Kurokawa* 56554 (TNS, US); Prov. Hyuga, *Hale* 29602; Hiroshima Prefecture: *Nakanishi and Oshio* 5731 (US); Kanto, *Numariri* 156 (US). Nepal: *Poelt* L-747, L-754 (M, US).

36. *Parmelina schindleri*, new species

Figure 19*a*

Description.—Thallus adnatus vel appressus, fragilis, corticola, pallide albo-cinereus, 2–4 cm latus, lobis sublinearibus, brevibus, contiguis, ca. 1–1.5 mm latis, margine ciliatis, ciliis 0.2–0.4 mm longis, simplicibus, margine et pro parte superficie lobulatis, lobulis congestis, suberectis, ramosis, 0.1–0.2 mm latis et usque ad 1 mm longis, margine breve ciliatis; superne nitidus, planus; cortex superior 14–15 μm crassus, epicorticatus, stratum gonidiale 12 μm crassum, medulla alba, 50–65 μm crassa, cortex inferior paraplectenchymatus, 12 μm crassus; subtus niger, modice rhizinosus, rhizinis nigris, simplicibus vel sparse furcatis. Apothecia rara, sessilia, margine crenato, 3–4 mm diametro, sporis 8:nae, 10 × 16–18 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K−, C−, KC+ rose, P− (traces of gyrophoric acid and the "horrescens" unknown).

Holotype.—Caraça, Minas Gerais, Brazil, *Vainio* in *Lichenes Brasilienses Exsiccati* 1284 (BM; isotypes in FH, M, TUR, and UPS).

Distribution.—Brazil.

Remarks.—The chemical constituents place this species in the "horrescens" group, where it is the lobulate morph of a parent species represented by *P. damaziana* or a now extinct progenitor similar to it. The dense lobules are easily recognized (Figure 4*e*). They do not originate from isidia and for this reason *P. schindleri* cannot be considered as a modified form of *P. horrescens*, which may occasionally have cylindrical and flattened isidia intermixed. The species is named in honor of Dr. H. Schindler, the first lichenologist to collect the species since Vainio in 1885, although this region has been visited by many lichen collectors. Vainio had misidentified his exsiccate number 1284 as *Parmelia coronata* var. *isidiosa* Müller Argoviensis (= *Bulbothrix fungicola* (Lynge) Hale).

Specimens Examined.—Brazil: Rio de Janeiro, *Schindler* 4569, 4577 (KR, US).

37. *Parmelina simplicior*

Figure 19*b*

Parmelina simplicior (Hale) Hale, 1974:483.

Parmelia simplicior Hale, 1972a:99 [type collection: Panchgani, Western Ghats, India, *D. D. Awasthi* 4056 (US, holotype; isotype in Awasthi herbarium)].

Description.—Thallus adnate on bark, buff mineral gray, coriaceous, 8–10 cm broad; lobes elongate, more or less subirregular, contiguous and becoming imbricate, 3–5 mm wide, the axils sparsely ciliate, the cilia 0.5 mm long; upper surface plane, continuous, emaculate, isidia and soredia lacking; medulla white; lower surface black, sparsely to moderately rhizinate, the rhizines simple, black. Apothecia common, sessile, 3–6 mm in diameter; spores 8, 4 × 6 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K+ yellow turning red, C−, KC−, P+ orange (salazinic acid).

Distribution.—South India.

Remarks.—*Parmelina simplicior* has a rather leathery thallus and very sparsely developed axillary cilia. As with many other Indian lichens it does not exhibit clear-cut traits that enable one to place it immediately in a particular genus. I had mentioned a possible relationship to isidiate *P. wallichiana*, which has much larger spores and a more membranous thallus, but these two species are not at all related. *Parmelina simplicior* grows on roadside trees in the Western Ghats region of India where an intense monsoon season from June to September alternates with a long period of almost total drought. *Parmelina wallichiana*, on the other

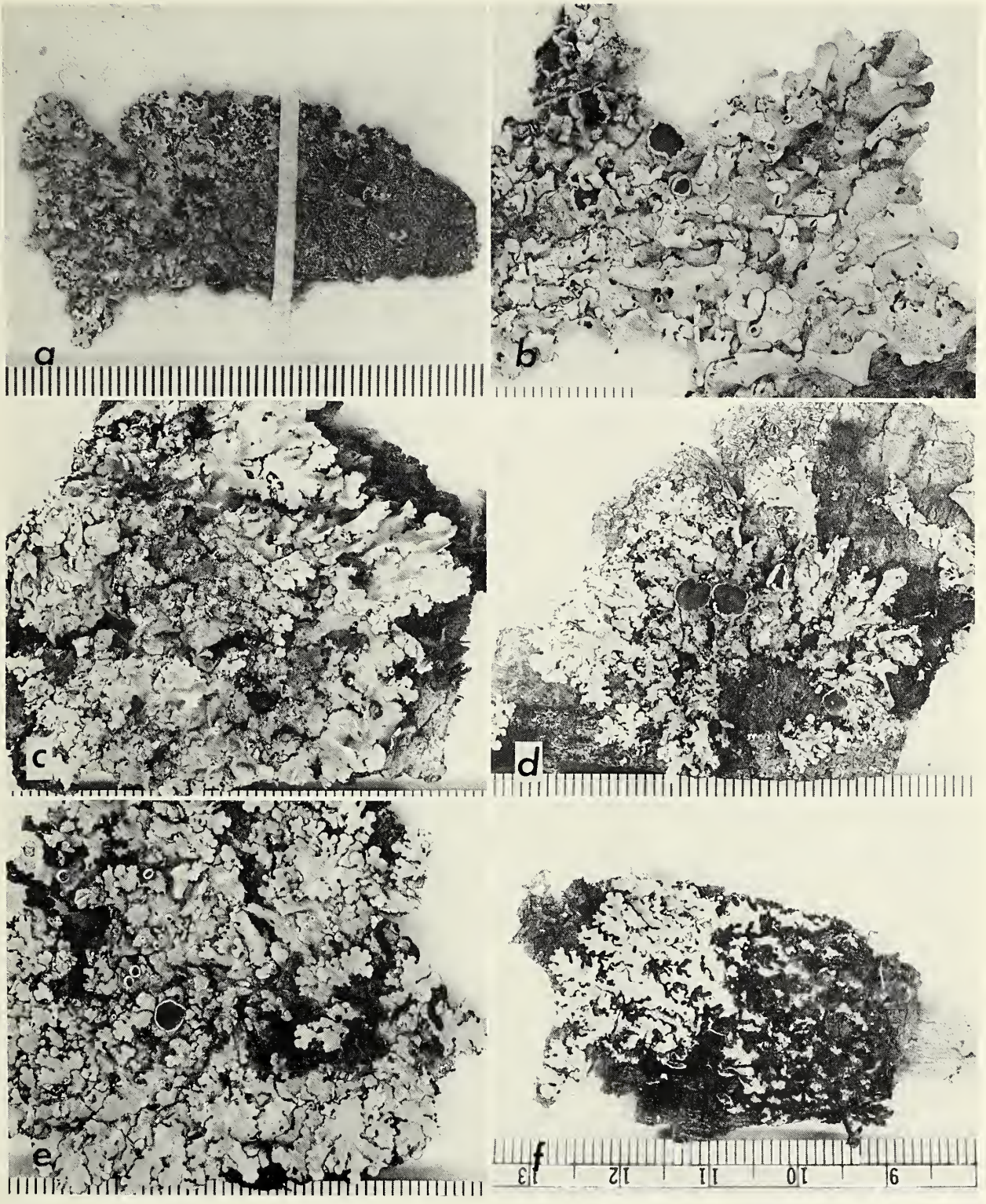

FIGURE 19.—Species of *Parmelina: a, P. schindleri* (*Vainio* 1284 in BM); *b, P. simplicior* (*Awasthi* 4056 in US); *c, P. spathulata* (*Almborn* 9516 in US); *d, P. spumosa* (*Hale* 42934a); *e, P. subaurulenta* (*Hale* 43705); *f, P. subfatiscens* (*Hale* 35094). (Scale in mm.)

hand, occurs at higher elevations with less climatic stress.

Specimens Examined.—India: Maharashtra, *Hale* 40004, 40007, 40046, 40090, 43972.

38. *Parmelina spathulata*

Figure 19*c*

Parmelina spathulata (Kurokawa) Hale, 1974:483.

Parmelia spathulata Kurokawa in Hale and Kurokawa, 1964:133 [type collection: Skeleton Gorge, Wynberg, Union of South Africa, *Almborn* 305 (LD, holotype; isotype in US)].

Description.—Thallus adnate on bark, pale whitish glaucous-green, fragile, 2–5 cm broad; lobes sublinear, crowded, 1–3 mm wide, the marginal cilia evenly dispersed, about 0.5 mm long; upper surface plane, continuous, moderately isidiate, the isidia initially cylindrical and erect but soon becoming procumbent and flattened; lower surface black, moderately rhizinate, the rhizines black, simple to rarely furcate. Apothecia not seen.

Chemistry.—Cortex K+ yellow (atranorin); medulla K−, C+, KC+ rose to red, P− (gyrophoric acid).

Distribution.—South Africa.

Remarks.—This lobulate-isidiate species (Figure 4*d*) is obviously a member of the *P. dissecta* group. It occurs only in southern Africa and is much less common than *P. dissecta*, which has smaller, normal isidia.

Specimens Examined.—Union of South Africa: Cape Province, *Kofler* (LD, US). Additional records from South Africa are given in Hale and Kurokawa (1964:134).

39. *Parmelina spumosa*

Figure 19*d*

Parmelina spumosa (Asahina) Hale, 1974:483.

Parmelia spumosa Asahina, 1951b:259 [type collection: Higashi-Murayama, Kita-Tama-gun, Prov. Musashi, Japan, *Asahina* (TNS, lectotype)].

Description.—Thallus closely adnate on bark, fragile, pale olive gray, 2–6 cm in diameter; lobes sublinear, 0.5–2 mm wide, the marginal cilia distinct and evenly dispersed, about 0.5 mm long; upper surface plane, continuous, emaculate, densely pustulate-isidiate, the pustules bursting but not becoming sorediate; medulla faintly yellow; lower surface moderately rhizinate, black, the rhizines simple or furcate. Apothecia rare, adnate, 1–3 mm in diameter, the amphithecium pustulate; spores 8, 7–8 × 12–14 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K−, C+ rose, KC+ red, P−, (gyrophoric acid, an unidentified pigment, and frequently a white fluorescent spot).

Distribution.—Pantropical at higher elevations.

Remarks.—This widespread but rather rare species is characterized by the dense, erupting but nonsorediate pustules (Figure 5*e,f*) and the pale yellowish medulla. The main constituent, gyrophoric acid, places it in the *P. dissecta* group, but it probably represents a different line of evolution from a now extinct parent morph (Figure 9). The chemistry is somewhat aberrant from *P. dissecta* and related species judging by the presence of a white UV-fluorescent spot in more than half of the specimens (including the lectotype) from both the New World and the Old World. The spot is not reactive with H_2SO_4 and its identity is not known.

Parmelina spumosa has ecological requirements similar to those of *P. dissecta* and *P. horrescens*. Much less common at temperate latitudes than the latter two, it grows throughout the tropics on exposed trees (hardwoods and conifers) and more rarely on rocks in forests up to 2500 m elevation.

Specimens Examined.—Mexico: Chiapas, *Hale* 19897, 20110a, 20150. Cuba: *Hioram* 6682 (US). Jamaica: *Imshaug* 14279, 15646 (MSC, US). Colombia: Antioquia, *Nee and Mori* 4258a (US). Venezuela: Mérida, *Hale* 42957, 42934a, 43037a. Brazil: São Paulo, *Eiten and Mimura* 5738 (US). Chile: Chiloe, *Santesson* 2264 (S, US); Valdivia, *Santesson* 7066 (S). St. Helena: *Loveridge* (BM). Union of South Africa: Cape Province, *Almborn* 749, 2663 (LD), 3966 (LD, US), *Degelius* SA–403 (Degelius herbarium, US); Natal, *Almborn* 10069 (LD). Madagascar: *Lemaitre* (H). Indonesia: Java, *Groenhart* 2218 (L), *Neervoort* 3354 (BOR), *Oka* 4089 (L). India: Tamil Nadu, *Hale* 43829. Japan: Prov. Aki, *Hale* 29529, 29540; Prov. Hizen, *Kurokawa* 63159 (TNS); Prov. Izu, *Asahina* (TNS); Prov. Mino, *Asahina* (TNS); Prov. Ohmi, *Hale* 29472, 29482; Prov. Sagami, *Asahina* 40 (TNS), *Kurokawa* 58038 (TNS, US); Prov. Shimofusa, *Asahina* (TNS); Prov. Suwo, *Asahina* 125 (TNS). Taiwan: *Kurokawa* 494 (TNS). Australia: Victoria, *Johnson* (BM). New Zealand: *Knight* (UPS), *Martin* 493, 566 (BM).

40. *Parmelina subaurulenta*

Figure 19*e*

Parmelina subaurulenta (Nylander) Hale, 1974:483.

Parmelia subaurulenta Nylander, 1885:606 [type collection: Narkanda, N. W. Himalayas, India, *Skoliczka* (H, Nylander herbarium number 35672, lectotype)].
Parmelia homogenes Nylander, 1885:607 [type collection: India, *Hooker and Thomson* 1942 (H, Nylander herbarium number 35664, lectotype)].
Parmelia conspicua Hue, 1899:145 [type collection: Kiao Che-Tung, above Kiang-Yn, Yunnan, China, *Delavay* (PC, lectotype)].
Parmelia homalotera Hue, 1899:159 [type collection: above Mo-So-Yn, Yunnan, China, *Delavay* (PC, lectotype)].
Parmelia fecunda Hue, 1899:169 [type collection: Ta-Pin-Tze, Yunnan, China, *Delavay* 5 (PC, lectotype)].
Parmelia subcremea Zahlbruckner, 1934b:208 [type collection: Between Muli Gomba, Baurong, and Wa-Erh-Dje, Setchwan, China, *Rock* 16720 pro parte (W, lectotype)].
Parmelia subaurulenta var. *myriocarpa* Asahina, 1951a:227 [type collection: Mt. Koya, Prov. Kii, Japan, *Inumaru* 1232 (TNS, lectotype)].
Parmelia homogenes f. *minor* Asahina, 1952:78 [type collection: Yamanaka, Prov. Kai, Japan, *Asahina* (TNS, lectotype)].
Parmelia myriocarpa (Asahina) Chao, 1964:149.
Parmelina homogenes (Nylander) Hale, 1974:482.

Description.—Thallus adnate to closely adnate on bark, light greenish mineral gray, rather fragile, 4–10 cm broad; lobes sublinear, subimbricate, 2–4 mm wide, the marginal cilia quite dense in the axils, irregularly dispersed at the lobe tips, 0.4–0.7 mm long; upper surface plane, faintly maculate, shiny, isidia and soredia lacking; medulla pale orange-yellow; lower surface black, densely rhizinate, the rhizines simple or becoming squarrosely branched. Apothecia very numerous, adnate, 1–3 mm in diameter; spores 8, 6–10 × 8–14 μm, usually abundantly developed.

Chemistry.—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylin and associated terpenes, secalonic acid A, and traces of unidentified substances).

Distribution.—Eastern Asia from India to Japan.

Remarks.—*Parmelina subaurulenta* is characterized by a thin thallus (average thickness for 20 specimens 154 μm), numerous apothecia rarely exceeding 3 mm in diameter, and well developed spores 6–9 × 8–12 μm. Nylander (1885:607) described *Parmelia homogenes* at the same time on the basis of a single specimen, citing as the main difference spore size ("similis *subaurulenta* . . . sed sporis majoribus"). Nylander measured spores 8–10 × 14–16 μm but my own measurements on the type specimen gave 7–8 × 12–13 μm, putting it well within the range of spore size for *Parmelina subaurulenta*. Without a significant difference in spore size, *P. homogenes* must be regarded as a synonym of *P. subaurulenta*.

The species most often confused with *P. subaurulenta*, especially outside of India, is *P. irrugans*, which has consistently larger apothecia (up to 10 mm in diameter), somewhat larger spores, and the "aurulenta" terpene series. Two of Nylander's syntypes for *Parmelia subaurulenta* are, in fact, *P. irrugans*, as discussed above under that species. All specimens should be tested with chromatography, although diameter of the apothecia is often adequate to separate the species in this group. All type specimens listed in the synomymy above were tested with thin-layer chromatography except for *Parmelia conspicua* Hue, which is placed here on the basis of the small apothecia.

Specimens Examined.—Nepal: *Poelt* 156 (M). India: Sikkim, *Hara et al.* (TNS, US); Tamil Nadu, *Degelius* As–352 (Degelius herbarium), *Hale* 40214, 43705, 43761, 43834, *Perrottet* (H, Nylander herbarium number 35670, syntype of *Parmelia subaurulenta*), *Watt* 119 (BM); West Bengal, *Awasthi* 3919, 3921 (Awasthi herbarium, US). Sri Lanka: *Almquist* (H, Nylander herbarium number 35665). China: Yunnan, *Handel-Mazzetti* 89, 2458, 2453 (US, W), *Rock* 11747 (US). Taiwan: *Kurokawa* 873, 1208 (TNS). Japan: *Moseley* (H, Nylander herbarium number 35669, syntype of *Parmelia subaurulenta*); *Almquist* (H, Nylander herbarium number 36671).

41. *Parmelina subfatiscens*

Figure 19*f*

Parmelina subfatiscens (Kurokawa) Hale, 1974:483.
Parmelia subfatiscens Kurokawa in Hale and Kurokawa, 1964:134 [type collection: Louis Trichardt, Zoutpansberg, Transvaal, Union of South Africa, *Almborn* 6443 (LD, holotype; isotype in US)].

Description.—Thallus closely adnate on bark, fragile, whitish mineral gray, 3–7 cm broad; lobes sublinear-elongate, separate to contiguous, 0.5–1.5 mm wide, the marginal cilia distinct, simple, to 1.0 mm long; upper surface plane, shiny, continuous, pustulate laminally and subterminally (Figure 5*c*), exposed medulla in center of pustules turning black, pustules remaining entire or producing very coarse sorediate or isidiate-sorediate masses, often short ciliate in African material but very rarely so in the New World; medulla white; lower surface black, densely rhizinate, the rhizines simple, black. Apothecia rare, adnate, 1.5–4.0 mm in diameter; spores 8, 8–9 × 12–14 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K−, C−, KC+ rose, P− (trace of gyrophoric acid and the "horrescens" unknown substances).

DISTRIBUTION.—South Africa and the Caribbean region.

REMARKS.—The pustules of *P. subfatiscens* (Figure 5*c*) often erupt, leaving a central area of exposed medulla that blackens. Other pustules become coarsely sorediate with the soredia sometimes assuming the form of tiny isidia-like masses. The specimens from Africa usually produce short cilia on these isidioid masses and on the surface of the pustules. The tropical American population very rarely has any cilia. The chemistry of the neotropical and African populations is, as far as I can determine, within the limits of the solvent systems available, identical and equivalent to that in *P. horrescens*. Dey (1975:433) suggests that the neotropical specimens, along with some from the southern Appalachian Mountains in the United States, may represent a new species, based in part on the absence of cilia on the pustules. It is also true that the ecological requirements seem to be different. The neotropical specimens were all collected in upland virgin rain forest at or above 500 m elevation, whereas the African localities are in much drier forests. I prefer to keep a broader species concept until more complete morphological and ecological data can establish the case one way or the other.

SPECIMENS EXAMINED.—Panama: Cocle, *Hale* 43564. See Hale (1971a:24) for additional records from Dominica.

42. *Parmelina swinscowii*

FIGURE 20*a*

Parmelina swinscowii (Hale) Hale, 1974:483.

Parmelia swinscowii Hale, 1973b:4 [type collection: Mt. Kenya, Central Province, Kenya, *T. D. V. Swinscow* K 31/33 (BM, holotype; isotype in US)].

DESCRIPTION.—Thallus growing on soil or over mosses on soil, loosely attached, whitish mineral gray or darkening, fragile, 3–5 cm broad; lobes sublinear-elongate, imbricate, 1.5–2.0 mm wide, the margins sparsely ciliate, the cilia black, simple, about 0.5 mm long; upper surface plane to convex, shiny, becoming rugose and cracked toward the lobe tips, the tips remaining entire or becoming minutely dissected, turning coarsely pustulate-sorediate; medulla white; lower surface black, densely rhizinate, the rhizines black, simple. Apothecia unknown.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K−, C−, KC+ rose, P− (lobaric acid and salazinic acid).

REMARKS.—Since describing *P. swinscowii*, I have identified it among collections made by Rolf Santesson in southernmost Chile. The Chilean and African populations are identical in morphology and chemistry. In Kenya *P. swinscowii* grows in the alpine zone at over 3500 m elevation, and in Chile it occupies similar barren habitats on rock and soil near sea level.

As mentioned in the original description, *P. swinscowii* does not fit well into any of the parmelioid groups. It superficially resembles an "everniiform" *Parmelia*, such as sorediate, salazinic acid-containing *Everniastrum sorocheilum* (Vainio) Hale, but the rhizines are relatively short and the lobes not at all canaliculate. It intergrades to a certain extent with abnormally small forms of *Parmotrema cetratum* (Acharius) Hale or *P. reticulatum* (Taylor) Choisy, except that the upper surface is not reticulate and the lobes are sublinear. The species is probably best left in *Parmelina* where it is anomolous largely because of the presence of lobaric acid.

SPECIMENS EXAMINED.—Chile: Magallanes, *Santesson* 2159, 6381a, 6381b, 6478 (S, US); Tierra del Fuego, *Santesson* 1244 (S, US). Specimens from Kenya are listed in Hale, 1973b:4.

43. *Parmelina tiliacea*

FIGURE 20*b*

Parmelina tiliacea (Hoffmann) Hale, 1974:483.

Lichen tiliaceus Hoffmann, 1784:96, pl. 16: fig. 2 [type collection: Europe (not seen but illustrated in Hoffmann)].

Lichen scorteus Acharius, 1798:119 [type collection: Sweden (H-Ach, lectotype)].

Parmelia tiliacea (Hoffmann) Acharius, 1803:215.

Imbricaria tiliacea (Hoffmann) Koerber, 1855:70.

Parmelia quercifolia var. *scortea* f. *microphylla* Massalongo, 1856:175 [type collection: Campofontana, Verona, Italy, *Massalongo* in *Lichenes Ital.* 329 (UPS, lectotype)].

Parmelia scortea var. *papillosa* Gyelnik, 1931:284 [type collection: Nógrád, Hungary, *Fòriss* 599 (BP, holotype)].

Parmelia scortea var. *ramifica* Gyelnik, 1931:285 [type collection: Sóskö Mountains, Hungary, *Timkó* 4521 (BP, holotype)].

Parmelia scortea f. *visegradensis* Gyelnik, 1932a:444 [type collection: Visegrád, Pest, Hungary, *Timkó* (BP, holotype)].

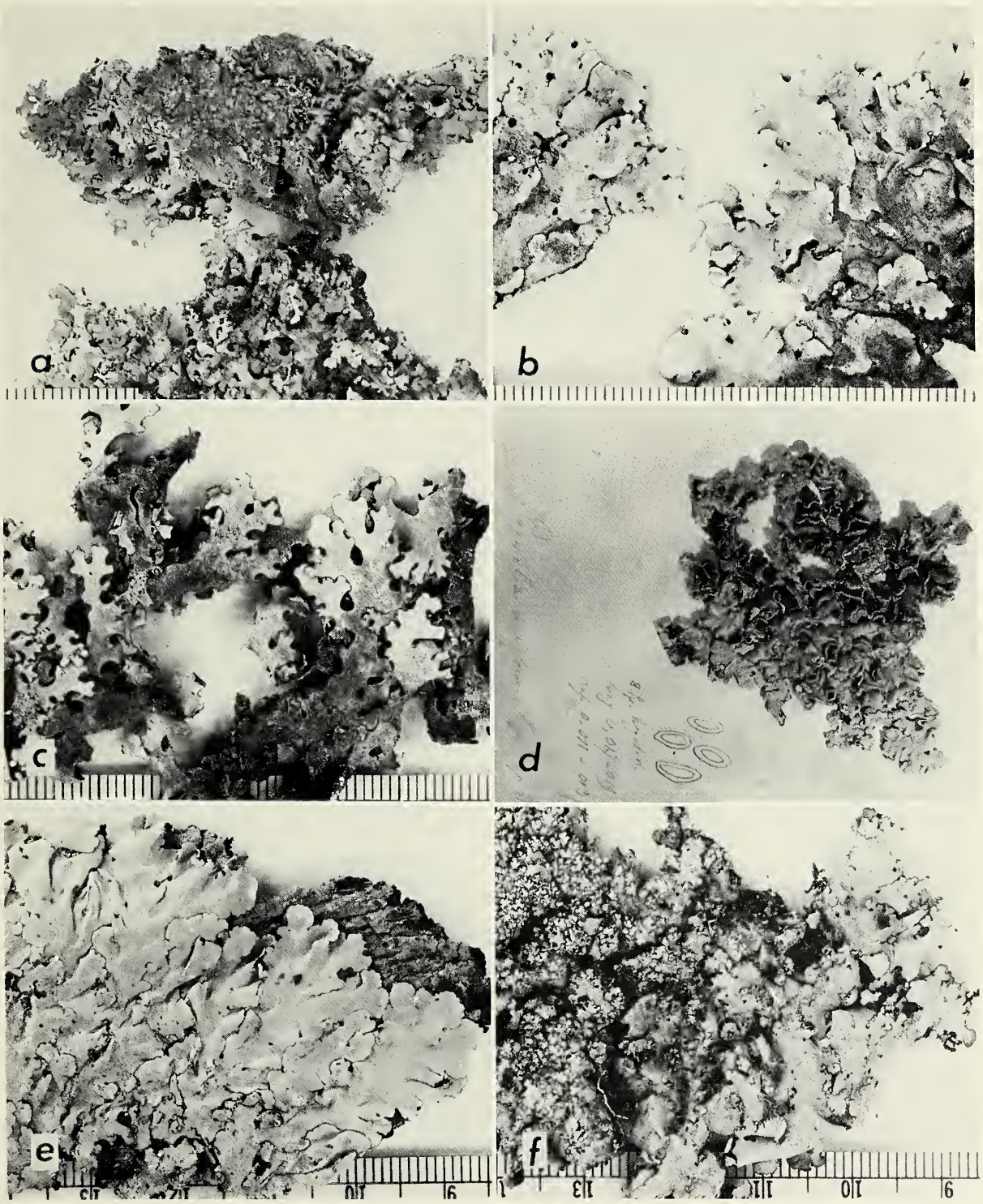

FIGURE 20.—Species of *Parmelina*: *a*, *P. swinscowii* (*Swinscow* K 31/33 in US); *b*, *P. tiliacea* (*Sampaio* in *Lichenes de Portugal* 250 in US); *c*, *P. usambarensis* (*Santesson* 10632 in US); *d*, *P. versiformis* (*Lorentz and Hieronymus* in M); *e*, *P. wallichiana* (*Santesson* 21339 in US); *f*, *P. xantholepis* (*Hale* 43862). (Scale in mm.)

Description.—Thallus adnate on bark or rock, light mineral gray to mineral gray, turning olive-buff to deep olive-buff in the herbarium, 5–15 cm or more in diameter; lobes irregularly branched, sublinear-elongate, often imbricate, rounded at the apices, 2–6 mm wide, the margins more or less crenate and undulate, sometimes narrowly black rimmed, ciliate, the cilia black, coarse, shiny, simple, 0.2–0.7 mm long; upper surface more or less shiny, white maculate, usually partly pruinose, irregularly cracked on older lobes, densely isidiate, the isidia cylindrical, short, rarely branched, usually blackening at the tips; medulla white; lower surface black, moderately to densely rhizinate, rhizines black, simple, 1–2 mm long. Apothecia rare, adnate, sometimes retrosely rhizinate, to 4 mm in diameter; spores 8, 5–6 × 8–11 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K−, C+, KC+ red, P− (lecanoric acid).

Distribution.—Europe to western India.

Remarks.—This classical European species was the first *Parmelina* to be described. Except for the nomenclatural confusion with Acharius' *Parmelia scortea*, it has been correctly identified by all lichenologists, excluding, of course, those in America, who used the name for *Parmelina galbina*. *Hypotrachyna livida* (Taylor) Hale, and other narrow-lobed lichens.

Parmelina tiliacea is the isidiate morph of *P. quercina*, which, surprisingly, has a much broader geographic range, contrary to the situation for most species pairs. A close relative in Britain and Europe is *P. pastillifera*, which has peltate isidia and different ecological requirements (Dobson and Hawksworth, 1976). Taken together, the three species form a distinct group in *Parmelina* characterized by the white maculae and presence of lecanoric acid. Only one other species in the genus, *P. pruinata*, contains this acid.

As one of the commonest parmelioid lichens in Europe, *P. tiliacea* has been mentioned and studied in detail by many workers. Sernander-Du Rietz (1926), for example, found that it tends to occur in ornithocoprous or dust-laden habitats in Scandinavia. She later conducted a careful study of apothecial formation, showing that growth of new apothecia could be correlated with heavy precipitation in warm periods of the summer (Sernander-Du Rietz, 1957).

Specimens Examined (selected).—Europe: England, *Crombie* (BM), *Davies* (BM), *Larbalestier* 292 (BM); Norway, *Höeg* (US), *Magnusson* 9193 (US); Sweden, *Almborn* (LD), *Asplund* (US), *Blomberg* in *Lichenes Sueciae Exsiccati* 64 (LD), *Santesson* 12711 (US), *Vrang* in *Kryptogamae Exsiccatae Vindobonensi* 3718 (LD, US); Finland, *Kari* in *Lichenes Fenniae Exsiccati* 194, 1103 (H), *Linkola* in *Lichenes Fenniae Exsiccati* 392 (H, US); Poland, *Glanc* in *Lichenotheca Polonica* 171 (UPS); Russia, in *Lichenotheca Rossica* 17 (WIS), *Oxner* (US); Bulgaria, *Szatala* (US); France, *Crozals* (US), *Rondon* in *Lichenes Selecti Exsiccati* 440 (US); Germany, *Erichsen* (US), *Hillmann* in *Kryptogamae Exsiccatae Vindobonensi* 3062 (US). *Paul and Schröppel* in *Lichenes Alpium* 9 (US); Czechoslovakia, *Pišut* in *Lichenes Slovakiae Exsiccati* 73 (US); Spain, *Culberson* 11954 (DUKE, US); Portugal, *Sampaio* in *Lichenes de Portugal* 250 (US); Italy, *Steiner* in *Kryptogamae Exsiccatae Vindobonensi* 4327 (US). Israel: *Pharan* 11 (US). Tunisia: *Runemark* (LD). Morocco: *Ernst* 2206 (US), *Newboula* 198 (BM). Bahrain: *Ahmad* L-162 (L, US). Pakistan: *Iqbal* 180 (L), 511,540 (US). India: Kashmir, *Kapoor* 991 (Awasthi herbarium), *Kaul* 4006 (Awasthi herbarium), *Watt* 117, 455 (BM).

44. *Parmelina usambarensis*

Figure 20*c*

Parmelina usambarensis (Steiner and Zahlbruckner) Hale, 1964:483.

Parmelia usambarensis Steiner and Zahlbruckner *in* Zahlbruckner, 1926:524 [type collection: Lutindi, Tanzania, *Brunnthaler* (W, lectotype)].

Parmelia laevigatoides des Abbayes, 1951:970 [type collection: Fouta-Djalon, Dalaba, Guinea, *des Abbayes* (REN, lectotype)].

Description.—Thallus loosely attached on rock, whitish mineral gray, to 10 cm broad; lobes broadly sublinear, divaricate to contiguous, 2–5 mm wide, the marginal cilia irregularly dispersed but mostly in the lobe axils, up to 1 mm long; upper surface shiny, plane, continuous or cracking in older parts, sparsely to densely isidiate, the isidia cylindrical, simple to branched, to 0.4 mm high; medulla white; lower surface black and shiny except for a narrow dark brown zone at the tips, moderately to sparsely rhizinate, the rhizines black, simple, 1 mm or more long. Apothecia rare, substipitate, the amphithecium isidiate, 2–3 mm in diameter; spores 8, 6 × 12 μm.

Remarks.—*Parmelina usambarensis* is a rather large, loosely attached, saxicolous lichen. The isidia are often quite sparse. It does not conform perfectly to the concept of *Parmelina* as I define the genus, but the simple rhizines and coarse, long marginal

cilia at least remove it from *Hypotrachyna* (Vainio) Hale. On the other hand, it cannot be accommodated in *Parmotrema* Massalongo because of the sublinear subdivaricate lobes. There are no close relatives, except, very superficially, the African endemic *Parmelina enormis*.

Specimens Examined.—Guinea: *Baldwin* 9849a (BM). Ivory Coast: Man, *des Abbayes* (LD, REN), *Santesson* 10632 (S, US). Uganda: *Swinscow* 2U 15/6 (BM, US), *Thomas* 1678, 3029 (BM). Thailand: *Kurokawa* 1804, 1813, 1935, 1956 (TNS), 1958 (TNS, US), *Kurokawa* in *Lichenes Rariores et Critici Exsiccati* 41 (US).

45. *Parmelina versiformis*

Figure 20*d*

Parmelina versiformis (Krempelhuber) Hale, 1964:483.

Parmelia versiformis Krempelhuber, 1878:464 [type collection: Argentina, *Lorentz and Hieronymus* (M, lectotype; isolectotypes in G, PC)].

Parmelia mutata Vainio, 1890·39 [type collection: Sitio, Minas Gerais, Brazil, *Vainio* in *Lichenes Brasilienses Exsiccati* 539 (TUR, lectotype; isolectotypes in BM, FH, UPS)].

Parmelia catharinensis Müller Argoviensis, 1891:239 [type collection: Near Santa Catarina, Brazil, *Ule* 1891 (G, lectotype; isolectotype in W)].

Parmelia wettsteinii Zahlbruckner, 1909:173 [type collection: Near Taipas, São Paulo, Brazil, *Schiffner and Wettstein* (W, lectotype, isolectotype in G)].

Description.—Thallus adnate to loosely adnate on bark, turning deep olive-buff in the herbarium, about 8 cm in diameter; lobes irregularly branched, sublinear-elongate, more or less imbricate, 2–8 mm wide, the margins crenate, ciliate mostly in lobe axils, the cilia often sparse, to 0.5 mm long; upper surface more or less shiny, not maculate, wrinkled and irregularly cracked on older lobes, soredia and isidia lacking; medulla white; lower surface dark brown or blackening, more or less wrinkled, sparsely rhizinate, the rhizines pale brown, simple, 0.1–0.3 mm long. Apothecia common, substipitate, 2–10 mm in diameter, the rim crenate and undulate, the amphithecium rugose, the disc blackish brown; spores 8, 10–14 × 18–28 μm, the episporium about 3 μm thick.

Chemistry.—Cortex K+ yellow (atranorin); medulla K+ yellow turning red, C−, KC−, P+ orange (salazinic acid).

Distribution.—South America.

Remarks.—This is the only species of *Parmelina* in the New World with salazinic acid, excepting rare *P. swinscowii*. It is also unusual in having very large spores with a thick episporium as well as a lower surface that is dark brown to black rather than entirely black. The closest relative appears to be the Asian *P. expallida*, an isidiate species with smaller spores (Kurokawa, 1968a:192). Although *P. versiformis* occurs in a botanically well-known region, it has not been collected since 1901.

Specimens Examined.—Brazil: Minas Gerais, *Warming* 283, 285, 286 (M); Rio de Janeiro, *Burchell* 2409 (BM), *Glaziou* 1822, 1823 (M).

46. *Parmelina wallichiana*

Figures 20*e*, 21

Parmelina wallichiana (Taylor) Hale, 1974:483.

Parmelia wallichiana Taylor, 1847:176 [type collection: Nepal, *Wallich* (FH–Tayl, lectotype)].

Parmelia tiliacea var. *eximia* Steiner, 1888:138 [type collection: Usambara, Tanzania, *Meyer* (G, lectotype)].

Parmelia junodii Steiner, 1907:640 [type collection: Sanatorium, Cape Province, Union of South Africa, *Junod* 978 (G, lectotype)].

Parmelia nimandairana Zahlbruckner, 1934a:55 [type collection: Mt. Arisan, Taiwan, *Asahina* 63 (W, lectotype; isolectotype in TNS)].

Parmelia nimandairana f. *sublaevis* Asahina, 1952:139 [type collection: Mt. Buko, Prov. Musashi, Japan, *Asahina* 35 (TNS, lectotype)].

Description.—Thallus adnate to loosely adnate on bark or rock, yellowish glaucous to pale glaucous-green, 5–20 cm in diameter; lobes irregularly branched, apically rotund, 3–10 mm wide, the margins more or less crenate, lobulate with age, short ciliate, especially in the axils, the cilia about 0.5 mm long; upper surface shiny, not maculate, irregularly cracked on older lobes, sparsely isidiate, isidia cylindrical, mostly simply, less than 1 mm high; medulla white; lower surface black, moderately to sparsely short rhizinate, dark brown and naked or papillate in a rather wide zone near the tips, the rhizines black, simple. Apothecia rare, adnate, 2–7 mm in diameter; spores 8, 8–10 × 14–18 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K+ yellow turning red, C−, KC−, P+ orange (salazinic acid).

Distribution.—Africa and Asia (Figure 21).

Remarks.—This is the most widespread and com-

FIGURE 21.—Distribution of *P. wallichiana* based on all available herbarium specimens.

monly collected *Parmelina* in the Old World. It is easily recognized by the adnate, moderately isidiate thallus that grows in a variety of habitats in the highlands of Africa, India, and eastern Asia, ranging from temperate Japan to both higher elevations in the tropics and to rather low elevations near the equator in Guinea and the Ivory Coast. The parent morph is no longer extant nor are the parallel sorediate or pustulate morphs.

SPECIMENS EXAMINED.—Guinea: N'Zérékoré, *Santesson* 10568b (UPS, US). Ivory Coast: Man, *Santesson* 10650 (UPS). Uganda: *Dummer* 5064 (US), *Swinscow* 2U 24/20 (BM, US). Kenya: Nyanza Province, *Maas Geesteranus* 10935 (L, LD, US), 4950, 11164 (L); Rift Valley Province, *Maas Geesteranus* 4832 (L). Angola: Cuanza Sul, *Degelius* (Degelius herbarium, US). Rhodesia: *Höeg* (TRH). Tanzania: Arusha Province, *Santesson* 21339 (UPS, US); Kilimanjaro Province, *Santesson* 20961, 20989, 20990 (UPS, US); Moshi District, *Burnet* T122 (BM, US). Swaziland: *Almborn* 7901 (LD), *Kofler* (LD). Union of South Africa: Natal, *Almborn* 8494 (LD), 8683, 9732, 9871 (LD, US), *Höeg* (TRH), *Kofler* (LD); Transvaal, *Almborn* 6430 (LD). Madagascar: *des Abbayes* in *Licheues Madagascarienses et Borbonici Selecti Exsiccati* 10 (UPS, US, distributed as *Parmelia isidiza*). Nepal: *Awasthi* 2156, 2157, 2198, 2203 (Awasthi herbarium), *Norkett* 5533 (BM), *Togashi* (TNS, US). Sikkim: *Bose* 136 (Awasthi herbarium). India: Uttar Pradesh, *Awasthi* 3175, 3509, 3814, 3980, 3986 (Awasthi herbarium), *Hara* (TNS, US); Tamil Nadu, *Foreau* 43 (Awasthi herbarium), *Hale* 40220, 40274, 43620, 43740, 43870. Thailand: *Kerr* L4 (BM). Malaya: Pahang: *Hale* 30094, 30217, 30218, 30219. Taiwan: *Kurokawa* 29, 530, 626, 2926 (TNS). China: Kwantung Province, *Peng* 12578 (US); Manchuria, *Asahina* 25 (TNS). Hong Kong: *Thrower* 1586 (US). Japan: Prov. Aki, *Hale* 29508; Prov. Chikuzen, *Kurokawa* 62545 (TNS); Prov. Higo *Kurokawa* 63076 (TNS); Prov. Hizen, *Kurokawa* 63157 (TNS); Prov. Hyuga, *Hale* 29645; Prov. Iyo, *Kurokawa* 60098 (TNS); Prov. Izu, *Asahina* 94 (TNS); Prov. Kii, *Asahina* (TNS), *Kurokawa* 60237 (TNS, US), *Kurokawa* in *Lichenes Rariores et Critici Selecti* 42 (US); Prov. Musashi, *Asahina* 11 (TNS), *Kurokawa* 59155 (TNS, US); Prov. Ohmi, *Hale* 29460; Prov. Satsuma, *Kurokawa* 63043 (TNS); Tosa, *Fujikawa* (TNS). *Yoshimura* 1157 (US). Philippines: Benguet, *Degelius* As–787 (Degelius herbarium), *Hale* 26760, *Hale* in *Lichenes Selecti Exsiccati* 672 (US); Mountain Province, *Hale* 26413. Sabah: *Hale* 28707, 28807, 29063, 29071. Indonesia: Java, *Groenhart* 3238 (L, US), 4358, 5881, 5913, 5917 (L), 5948 (L, US), *Schiffner* 3294 (US), *Voogd* 2079 (L).

47. *Parmelina xantholepis*

FIGURE 20*f*

Parmelina xantholepis (Montagne and van den Bosch) Hale, 1974:438.

Parmelia xantholepis Montagne and van den Bosch, 1855:428 [type collection: Gode, Java, *Teydom* (L, lectotype)].

Parmelia biformis Vainio f. *dataensis* Vainio [= f. *biformis*], 1909:660 [type collection: Mt. Data, Luzon, Philippines, *Merrill* 4987 (TUR, Vainio herbarium number 2607, lectotype)].

Parmelia biformis f. *pauaiensis* Vainio, 1909:660 [type collection: Pauai, Benguet, Luzon, Philippines, *Mearns* 4434 (TUR, Vainio herbarium number 2605, lectotype)].

DESCRIPTION.—Thallus adnate on bark or rock, yellowish mineral gray, very fragile, 4–15 cm broad; lobes sublinear to subirregular, 1–3 mm wide, crowded, dissected, the marginal cilia coarse, 0.2–0.8 mm long; upper surface plane, maculate, becoming densely lobulate toward the lobe margins, isidia and soredia lacking; medulla barium yellow; lower surface black, densely rhizinate, the rhizines black, long, simple or squarrose. Apothecia adnate, 1–3 mm in diameter; spores 6–8 × 9–13 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla more intensively yellow with K and C, P− (zeorin, leucotylin and related terpenes, and secalonic acid A.)

DISTRIBUTION.—India and Nepal to the Philippines.

REMARKS.—This species is easily identified by the fragile, lobulate thallus with a pale yellow-orange medulla. It is closely related to the *P. amagiensis–P. denegans* series, definitely in chemistry but less so in thallus texture. It is usually collected at the base of trees or on rocks, often growing among mosses, at higher elevations (1000–2300 m) in evergreen hardwood cloud forests.

SPECIMENS EXAMINED.—Nepal: *Poelt* 101, 111 (M), *Norkett* 9227 (BM). India: Tamil Nadu, *Foreau* 4118 (Awasthi herbarium, US), *Hale* 43862; Uttar Pradesh, *Awasthi* 3839 (Awasthi herbarium). Thailand: *Kurokawa* 1669 (TNS, US). Philippines: Mountain Province, *Hale* 25993, 26056, 26187, 26344, 26554. Indonesia: Java, *Groenhart* 2841, 5939 (L), 5941, 6004 (L, US).

Doubtful and Rejected Names

Parmelia coilocarpa

Parmelia coilocarpa Stirton, 1877–78:202 [type collection: Fernando Po, West Africa, *G. Thomson* (BM, lectotype; GLAM, isolectotype)].

The type material is too fragmentary for adequate study. It is a nonsorediate, nonisidiate, subirregularly lobed species with a black lower surface, simple rhizines, and numerous marginal cilia. The spores are large, 15 × 28 μm. Atranorin and salazinic acid are present. It is almost certainly a *Parmelina,* and its status will only be clarified as more collections are made in West Africa.

Parmelia orchidophlia

Parmelia orchidophila Dodge, 1953:374 [type collection: Nyinabitsa, Western Province, Uganda, *Omastin* 1184 (BM, lectotype)]

The type collection is too fragmentary for study. Salazinic acid was proved microchemically. It may be *Parmelina wallichiana* (Taylor) Hale.

Parmelia tiliacea var. *leucina*

Parmelia tilicea var. *leucina* Müller Argoviensis, 1880:267 [type collection: Near Petropolis, Brazil, *Deventer* (G, lectotype)].

This variety is equal to *Hypotrachyna dactylifera* (Vainio) Hale (Hale, 1975a:30).

Parmelia tilacea var. *rimulosa*

Parmelia tilicea var. *rimulosa* Müller Argoviensis, 1882:458 [type collection: Socotra, *Balfour* (G, lectotype)].

No type specimen could be located at Geneva. One of two specimens so labeled by Müller is *Parmotrema reticulatum* (Taylor) Choisy, and the other is *Pseudoparmelia carneopruinata* (Zahlbruckner) Hale.

Parmelina baguioensis

Parmelina baguioensis (Hale) Hale, 1974:482 [type collection: Baguio, Mountain Province, Philippines, *Hale* 26768 (US, holotype)].

Closer examination of this sorediate species convinced me that it is a member of the genus *Hypotrachyna* (*H. baguioensis* (Hale) Hale, new combination). The rhizines are rather sparse but clearly

dichotomously branched at maturity. In any event, the chemistry—fumarprotocetraric acid—was anomalous for *Parmelina,* and this was the first clue to its correct generic status.

Parmelina carporrhizans

Parmelina carporrhizans (Taylor) Hale, 1974:482.

I now consider this to be a synonym of *Parmelina quercina.*

Parmelina crystallorum

Parmelina crystallorum (Lynge) Hale, 1974:482.

This species is synonymized under *Parmelina damaziana.*

Parmelina homogenes

Parmelina homogenes (Nylander) Hale, 1974:482.

I have placed this species in synonymy under *Parmelina subaurulenta.*

Parmelina nylanderi

Parmelina nylanderi (Lynge) Hale, 1974:483.

Parmelia nylanderi Lynge, 1914:82 [type collection: Near São Jeronymo, Serra da Chapada, Mato Grosso, Brazil, *Malme* 2747 (S, lectotype)].

I originally considered this loosely attached saxicolous lichen to be a member of *Parmelina,* but after examining a second collection (*Eiten* 3429 (US) from São Paulo, Brazil), I now feel that the chemistry (usnic acid in the cortex and salazinic and gyrophoric acid in the medulla) and general habit, in spite of the narrow ciliate lobes, place it more appropriately in *Parmotrema* (*P. nylanderi* (Lynge) Hale, new combination). It is related to the much broader lobed *P. delicatulum* (Vainio) Hale group so common on sandstone in South America.

Literature Cited

des Abbayes, H.
1951. Lichens recoltés en Guinée française et en Côte d'Ivoire. *Bulletin de l'Institut Français d'Afrique Noire,* 13 (4):965–977.

Acharius, E.
1794. Försök til en förbättrad lafvarnes indelning (Dianome Lichenum). *Konglige Vetenskaps-Academiens Handlingar,* 12:237–254.
1798. *Lichenographiae Suecicae Prodromus.* 264 pages. Lincopiae.
1803. *Methodus qua omnes detectos lichenes.* 394 pages. Stockholmiae.
1814. *Synopsis methodica lichenum.* 392 pages. Lundae.

Asahina, Y.
1951a. Lichenes Japoniae novae vel minus cognitae (4). *Journal of Japanese Botany,* 26:225–228.
1951b. Lichenes Japoniae novae vel minus cognitae (5). *Journal of Japanese Botany,* 26:257–261.
1951c. Lichenes Japoniae novae vel minus cognitae (6). *Journal of Japanese Botany,* 26:289–293.
1952. *Lichens of Japan,* II: Genus *Parmelia.* 162 pages. Tokyo.
1960. Lichenologische Notizen (160–163). *Journal of Japanese Botany,* 35:97–102.
1963. Lichenologische Notizen (191). *Journal of Japanese Botany,* 38:225–228.

Berry, E. C.
1941. A Monograph of the Genus *Parmelia* in North America, North of Mexico. *Annals of the Missouri Botanical Garden,* 28:31–146.

Bouly de Lesdain, M.
1914. *Lichens de Mexique.* 31 pages. Mexico.

Burnham, S. H.
1922. Lichens of the Lake George Region. *Bryologist,* 25:72–80.

Cengia Sambo, M.
1938. Licheni del Kenia e del Tanganica raccolti dai Rev. Padri Della Consolata. *Nuovo Giornale Botanico Italiano,* 45:364–387.

Chao, Chi-ding
1964. [A Preliminary Study on Chinese Parmelia.] *Acta Phytotaxonimica Sinica,* 9:139–166. [In Chinese.]

Culberson, C.
1972. Improved Conditions and New Data for the Identification of Lichen Products by a Standardized Thin-Layer Chromatographic Method. *Journal of Chromatography,* 72:113–125.

Culberson, W.
1955. The Corticolous Communities of Lichens and Bryophytes in the Upland Forests of Northern Wisconsin. *Ecological Monographs,* 25:215–231.
1958. Variation in the Pine-inhabiting Vegetation of North Carolina. *Ecology,* 39:23–28.
1961. The *Parmelia quercina* Group in North America. *American Journal of Botany,* 48:168–174.
1972. Disjunctive Distributions in the Lichen-forming Fungi. *Annals of the Missouri Botanical Garden,* 59:165–173.

Dahl, E., and H. Krog
1973. *Macrolichens of Denmark, Finland, Norway, and Sweden.* 185 pages. Oslo.

Degelius, G.
1940. Contributions to the Lichen Flora of North America, I: Lichens from Maine. *Arkiv för Botanik,* 30A (1):1–62.
1941. Contributions to the Lichen Flora of North America, II: The Lichen Flora of the Great Smoky Mountains. *Arkiv för Botanik,* 30A (3):1–80.

Dey, J.
1975. *The Fruticose and Foliose Lichens of the High Mountain Areas of the Southern Appalachians.* 603 pages. Unpublished Ph.D. dissertation, Duke University.

Dobson, F. S., and D. L. Hawksworth
1976. *Parmelia pastillifera* (Harm.) Schub. & Klem. and *P. tiliacea* (Hoffm.) Ach. in the British Isles. *Lichenologist,* 8:47–59.

Dodge, C. W.
1953. Some Lichens of Tropical Africa. *Annals of the Missouri Botanical Garden,* 40:271–412.
1959. Some Lichens of Tropical Africa, III: Parmeliaceae. *Annals of the Missouri Botanical Garden,* 46:39–193.

Fink, B.
1935. *The Lichen Flora of the United States.* 426 pages. Ann Arbor.

Fries, E.
1825. *Systema orbis vegetabilis.* Part 1, 374 pages. Lund.

Gyelnik, V.
1931. Additamenta ad cognitionem Parmeliarum, II. *Fedde Repertorium,* 29:273–291.
1932a. Enumeratio lichenum europaeorum novorum rariorumque. *Annales Mycologici,* 30:442–455.
1932b. Additamenta ad cognitionem Parmeliarum, III. *Fedde Repertorium,* 30:209–226.

Hale, M. E., Jr.
1955. Phytosociology of Corticolous Cryptogams in the Upland Forests of Southern Wisconsin. *Ecology,* 36:45–63.

1958. Studies on the Chemistry and Distribution of North American Lichens (10–13). *Bryologist,* 61:81–85.
1959. New or Interesting Parmelias from North and Tropical America. *Bryologist,* 62:123–132.
1960. A Revision of the South American Species of *Parmelia* Determined by Lynge. *Contributions from the United States National Herbarium,* 36:1–41.
1965. A Monograph of *Parmelia* Subgenus *Amphigymnia. Contributions from the United States National Herbarium,* 36:193–358.
1967. Chemistry and Evolution in Lichens. *Israel Journal of Botany,* 15:150–157.
1971a. Morden-Smithsonian Expedition to Dominica: The Lichens (Parmeliaceae). *Smithsonian Contributions to Botany,* 4:1–25.
1971b. Two Species of *Parmelia* New to North America. *Bryologist,* 74:44–47.
1972a. Four New Species of *Parmelia* (Lichenes) from India and the Philippines. *Bryologist,* 75:97–101.
1972b. *Parmelia jamesii,* an Unusual Species in Section *Imbricaria* (Lichenes) from Australia and New Zealand. *Phytologia,* 23:179.
1972c. Six New Species of *Parmelia* (Lichenes) from Africa. *Phytologia,* 23:343–349.
1973a. Fine Structure of the Cortex in the Lichen Family Parmeliaceae Viewed with the Scanning-Electron Microscope. *Smithsonian Contributions to Botany,* 10:1–92.
1973b. New *Parmeliae* (Lichenes) from Africa. *Phytologia,* 27:1–6.
1974. *Bulbothrix, Parmelina, Relicina,* and *Xanthoparmelia,* Four New Genera in the Parmeliaceae (Lichenes). *Phytologia,* 28:479–490.
1975a. A Revision of the Lichen Genus *Hypotrachyna* (Parmeliaceae) in Tropical America. *Smithsonian Contributions to Botany,* 25:1–73.
1975b. A Monograph of the Lichen Genus *Relicina* (Parmeliaceae). *Smithsonian Contributions to Botany,* 26:1–32.
1976a. A Monograph of the Lichen Genus *Pseudoparmelia* Lynge (Parmeliaceae). *Smithsonian Contributions to Botany,* 31:1–62.
1976b. A Monograph of the Lichen Genus *Bulbothrix* Hale (Parmeliaceae). *Smithsonian Contributions to Botany,* 32:1–29.

Hale, M. E., Jr., and S. Kurokawa
1962. *Parmelia* Species First Described from the British Isles. *Lichenologist,* 2:1–5.
1964. Studies on *Parmelia* Subgenus *Parmelia. Contributions from the United States National Herbarium,* 36:121–191.

Harmand, J.
1897. Catalogue descriptif des Lichens observés dans la Lorraine. *Bulletin de la Société des Sciences de Nancy,* series 2, 14:1–510.
1910. *Lichens de France.* Volume 4, pages 483–732. Paris.
1928. Lichens d'Indo-Chine recueillis par M. V. Demange. *Annales Cryptogamie Exotique,* 1:319–337.

Hedrick, J.
1934. New Genera and Species of Lichens from the Herbarium of Bruce Fink, II. *Mycologia,* 26:153–166.

Hoffmann, G. F.
1784. *Enumeratio Lichenum.* 102 pages. Erlangae.

Hue, A. M.
1899. Lichenes extra-europaei. *Nouvelles Archives du Museum Paris,* séries 3, 1:1–250.

James, P. W.
1965. A New Check-List of British Lichens. *Lichenologist,* 3:95–153.

Koerber, G. W.
1855. *Systema Lichenum Germaniae.* 458 pages. Breslau.

Krempelhuber, A.
1878. Lichenes collecti in republica Argentina a Doctoribus Lorentz et Hieronymus. *Flora,* 61:461–464.

Kurokawa, S.
1968a. *Parmelia expallida,* a New Lichen Species from Eastern Asia. *Bulletin of the National Science Museum,* 11:191–194.
1968b. New or Noteworthy Species of *Parmelia* of Japan. *Journal of Japanese Botany,* 43:349–353.
1972. Probable Mode of Differentiation of Lichens in Japan and Eastern North America. Pages 139–146 *in* A. Graham, *Floristics and Paleofloristics of Asia and North America.* Amsterdam.

Kurokawa, S., and M. Mineta
1973. Enumeration of *Parmeliae* of Ceylon. *Annual Report of the Noto Marine Laboratory,* 13:71–76.

de Lamarck, J., and A. P. de Candolle
1805. *Flore Française.* Volume 2, 600 pages. Paris.

Lynge, B.
1914. Die Flechten der ersten Regnellschen Expedition. Die Gattungen *Pseudoparmelia* gen. nov. und *Parmelia* Ach. *Arkiv för Botanik,* 13 (13):1–172.

Massalongo, A. B.
1856. *Schedae Criticae.* Part 10, number 328.

Michaux, A.
1803. *Flora Boreali–Americana.* Volume 2, 340 pages. Paris.

Montagne, J. K. C., and R. B. van den Bosch
1855. Lichenes, Collemaceae. Pages 427–494 *in* F. Junghuhn, *Plantae Junghuhnianae* [*sive Enumeratio Plantarum quas in insulis Java et Sumatra*].

Moore, B. J.
1968. The Macrolichen Flora of Florida. *Bryologist,* 71: 161–266.

Müller Argoviensis, J.
1877. Lichenologische Beiträge, V: Lichenen aus Texas. *Flora,* 60:77–80.
1880. Licheologische Beiträge, XI. *Flora,* 63:260–268.
1882. Diagnoses Lichenum Socotrensium novorum. *Proceedings of the Royal Society of Edinburgh,* 11:457–472.
1883. Lichenologische Beiträge, XVII. *Flora,* 66:45–48.
1887. Lichenologische Beiträge, XXVI. *Flora,* 70:316–320.
1888a. Lichenes Montevidenses quos legit et communicavit Prof. Arechavaleta. *Revue Mycologique,* 10:1–5.
1888b. Lichenologische Beiträge, XXIX. *Flora,* 71:195–208.
1888c. Lichenologische Beiträge, XXX. *Flora,* 71:528–552.

1891. Lichenologische Beiträge, XXXV. *Flora,* 74:371–382.

Nylander, W.

1856. Prodromus Lichenographiae Galliae et Algeriae. *Actes de la Société Linnéenne de Bordeaux,* 21:249–467.

1868. Enumération des lichens recoltés par M. T. Husnot aux Antilles françaises. *Bulletin de la Société Linnéenne de Normandie,* (2)3:259–280.

1873. Observata Lichenologica in Pyrenaeis orientalibus. *Bulletin de la Société Linnéenne de Normandie,* (2)6:256–328.

1882. Addenda nova ad Lichenographiam europaeam. *Flora,* 65:451–458.

1885. *Parmeliae* exoticae novae. *Flora,* 68:605–615.

1890. *Lichenes Japoniae.* 122 pages. Paris.

1900. Lichenes Ceylonenses. *Acta Societatis Scientiarum Fennicae,* 26(10):791–821.

Poelt, J.

1961. Mitteleuropäische Flechten, VII. *Mitteilungen der Botanischen Staatssammlung München,* 4:171–197.

1969. *Bestimmungsschlüssel europäischer Flechten.* 757 pages. Lehre.

Schauer, T.

1965. Oceanische Flechten im Nordalpenraum. *Portugaliae Acta Biologica,* (B)8:17–229.

Schreber, J. C. D.

1791. *Linné, Genera Plantarum.* Eighth edition, 872 pages. Frankfurt am Main.

Schubert, R., and O. Klement

1966. Beitrag zur Flechtenflora von Nord- und Mittelindien. *Nova Hedwigia,* 11:1–73.

Sernander-Du Rietz, G.

1926. *Parmelia tiliacea,* en kustlav och marin inlandsrelikt i Skandinavien. *Svensk Botanisk Tidskrift,* 20:352–365.

1957. Om yttre faktores inverkan på apotheciebildningen hos *Parmelia tiliacea. Svensk Botanisk Tidskrift,* 51:454–488.

Shibata, S., S. Natori, and S. Udagawa

1964. *List of Fungal Products.* 170 pages. Tokyo.

Steiner, J.

1888. Ueber afrikanische Flechten. *Jahres-Bericht der Schlesischen Gesellschaft für vaterländische Cultur,* 66:133–150.

1907. Lichenes austro-africani. *Bulletin de l'Herbier Boissier,* 2(7):637–646.

Stirton, J.

1877–78. On Certain Lichens Belonging to the Genus *Parmelia. Scottish Naturalist,* 4:200–203.

1899. Lichenes. *In* F. M. Bailey, Contributions to the Flora of Queensland. *Queensland Agricultural Journal,* 5:483–488.

Stizenberger, E.

1890. Lichenaea africana. *Bericht über die Tätigkeit der St. Gallischen Naturwissenschaftlichen Gesellschaft,* 1888–89:105–209.

Taylor, T.

1836. Lichens. *In* J. T. Mackay, *Flora Hibernica.* 279 pages. Dublin.

1847. New Lichens, Principally from the Herbarium of W. J. Hooker. *Hooker Journal of Botany,* 6:148–197.

Tuckerman, E.

1858. Supplement to an Enumeration of North American Lichens: Part First, Containing Brief Diagnoses of New Species. *American Journal of Science and Arts,* series 2, 25:422–430.

1882. *A Synopsis of the North American Lichens.* 261 pages. Boston.

Vainio, E. A.

1890. Etude sur la classification naturelle et la morphologie des Lichens du Brésil. *Acta Societatis pro Fauna et Flora Fennica,* 7(7):1–247.

1896. Lichenes Antillarum a W. R. Elliott collecti. *Journal of Botany British and Foreign,* 34:31–36.

1899. Lichenes in Caucaso et in Peninsula Taurica annis 1884–1885 ab H. Lojka et M. a Déchy collecti. *Természetrajzi Füzetek,* 22:269–343.

1909. Lichenes Insularum Philippinarum, I. *Philippine Journal of Science,* 4:651–662.

Willdenow, C. L.

1787. *Florae Berolinensis Prodromus.* 440 pages. Berlin.

Yosioka, I.

1966. The Structure of Leucotylic Acid, a New Triterpenic Acid from a Lichen. *Tetrahedron Letters,* 6:607–612.

Yosioka, I., and T. Nakanishi

1963. Structure of Leucotylin. *Chemical Pharmaceutical Bulletin,* 11:1468–1470.

1966. On the Triterpenic Constituents of a Lichen, *Parmelia entotheiochroa* Hue, Zeorin, Leucotylin, Leucotylic Acid, and Five New Related Triterpenic Acids. *Chemical Pharmaceutical Bulletin,* 14:804–807.

Yosioka, I., T. Nakanishi, S. Izumi, and I. Kitagawa

1968a. Structure of a Lichen Pigment Entothein and its Identity with Secalonic Acid A, a Major Ergot Pigment. *Chemical Pharmaceutical Bulletin,* 16:2090, 2091.

Yosioka, I., T. Nakanishi, and I. Kitagawa

1968b. On the Stereostructures of Zeorin and Leucotylin. *Tetrahedron Letters,* 12:1485–1490.

Zahlbruckner, A.

1905. Lichenes a cl. Damazio in Brasilia lecti. *Bulletin de l'Herbier Boissier,* series 2, 5:539–543.

1908. Beiträge zur Flechtenflora Brasiliens. *Bulletin de l'Herbier Boissier,* series 2, 8:459–468.

1909. Lichenes (Flechten). *In* R. Wettstein and V. Schiffner, Ergebnisse der botanischen Expedition der kaiserlichen Akademie der Wissenschaften nach Südbrasilien 1901. *Denkschrift Akademie der Wissenschaften in Wien. Mathematisch-Naturwissenschaftliche Klasse,* 83:87–211.

1926. Afrikanische Flechten (Lichenes). *Botanische Jahrbücher für Systematik,* 60:468–552.

1927. Additamenta ad Lichenographiam Japoniae. *Botanical Magazine* (Tokyo), 41:313–364.

1929. *Catalogus lichenum universalis.* Volume 6, 323 pages. Leipzig.

1930. Lichenes. *In* H. Handel-Mazzetti, *Symbolae Sinica,* 3:1–254.

1934a. Flechten der Insel Formosa. *Fedde Repertorium* 33:22–68.

1934. Nachträge zur Flechtenflora Chinas. *Hedwigia,* 74:195–213.

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